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**THOMSON**

# BALL BUSHINGS®

*Unlimited Travel — Friction-Free LINEAR MOTION*



**THOMSON**  
INDUSTRIES, INC.

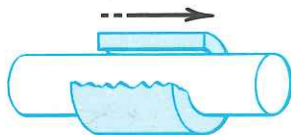
MANHASSET  
NEW YORK

Plants: PORT WASHINGTON, LONG ISLAND, N. Y. • LANCASTER, PENNSYLVANIA

- *Low Friction and Wear*
- *Lasting Precision Alignment*
- *Eliminate Binding and Chatter*
- *Zero Shake or Play*
- *Long Life — Low Maintenance*
- *Eliminate Stick-Slip*
- *Solve Sliding Lubrication Problems*

# The BALL BUSHING

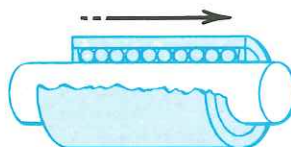
**A Final Solution to the troubles caused by sliding linear motions.**



Sliding linear motions are troublesome due to friction and wear. These factors cause binding, chatter, loss of alignment, lubrication difficulties and maintenance problems. These conditions are further aggravated in sliding linear motions where oil films, upon which the sliding depends, are exposed causing gumming and oxidation.



The many obvious advantages of ball bearings for rotary motions are widely recognized and their use has become universal. Oddly enough, until recently engineers have been required to slide linear motions and put up with the attendant troubles or resort to bulky and expensive wheel and track arrangements.



The development of BALL BUSHINGS has brought the engineer the long needed solution of the linear motion problem. Low friction, long life and sustained alignment can now be obtained by the use of BALL BUSHINGS on reciprocating parts. Your engineers and maintenance men well know the significance of this development.

Anti-friction bearings identify better products. If your product is manufactured for resale, your Sales Department will be quick to tell you the advantages of BALL BUSHINGS from its point of view.

# OPERATING PRINCIPLE

**A simple but ingenious system of ball re-circulation permits almost frictionless unlimited linear travel.**

Three or more oblong circuits of balls are provided within the bearing, each of which has the balls in one of its straight sides in bearing contact between the inner surface of the BALL BUSHING sleeve and the shaft. The load is actually rolled freely along on the balls in this portion of the circuit. Balls in the remainder of the circuit are free to roll in clearance provided in the sleeve.

A retainer within the sleeve guides the balls in their proper path and prevents them from falling out when the bearing is removed from the shaft. This makes the BALL BUSHING a neat compact unit, as easy to handle and install as a plain bushing.

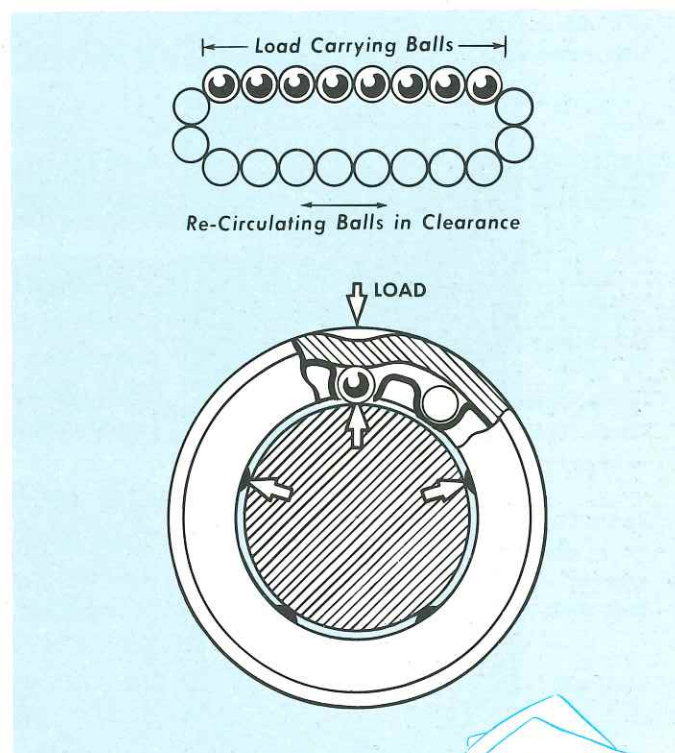
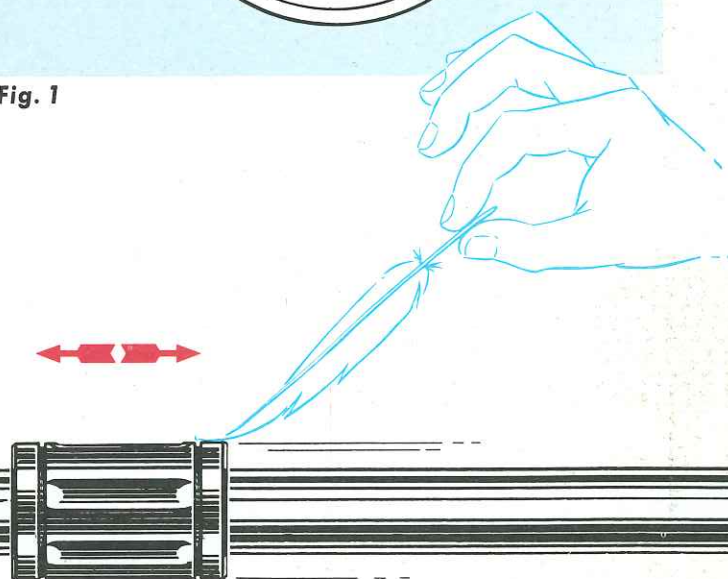


Fig. 1



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# BASIC TYPES of BALL BUSHINGS

• Listed below are the various standard types of BALL BUSHINGS which are available from stock and their basic design characteristics. A general description of each of these different types and installation recommendations for them may be obtained by referring to the pages indicated. General information applying to all types will be found on Pages 18 to 26. Engineering specifications are given on Pages 27 to 33.

## PRECISION Series "A"

*1/4" thru 4"*



SEE  
PAGES  
8 & 9

Series A BALL BUSHINGS are precision bearings manufactured for general use. They have a wide range of industrial applications and are suitable for use in machine tools, plant equipment and many types of precision mechanisms.

## SUPER PRECISION Series "XA"

*1/4" thru 4"*



SEE  
PAGES  
8 & 9

These are basically the same as the Series A BALL BUSHINGS except that they are manufactured to extremely close tolerances. Series XA are generally used in machines or mechanisms which require closer fits than the Series A will provide.

## COMMERCIAL Series "B"

*1/4" thru 1 1/2"*



SEE  
PAGES  
8 & 9

Series B BALL BUSHINGS are low cost bearings manufactured to order for direct shipment to large volume users. They are available only in sizes 1/4" thru 1 1/2" I.D. and are used in applications where high precision is not essential.

## INSTRUMENT Series "INST"

*1/8" thru 1/4"*

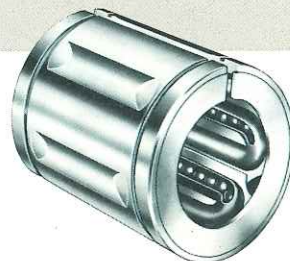


SEE  
PAGES  
16 & 17

Series INST BALL BUSHINGS are for use on 1/8", 3/16" and 1/4" shafts. Although small in size and extremely sensitive, these Bushings are extraordinarily rugged and capable of withstanding high vibrational and shock loads. Used in guidance, fire control, navigational systems, computers, inertial devices, instruments.

## ADJUSTABLE DIAMETER Series "ADJ"

*1/2" thru 4"*



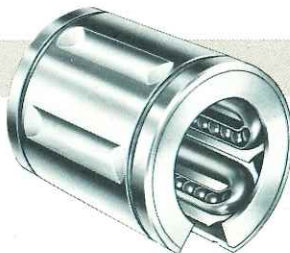
SEE  
PAGES  
10 & 11

Adjustable Diameter BALL BUSHINGS are split longitudinally and are designed to easily provide line-to-line or slight pre-load fits when mounted in adjustable diameter housings.

This construction eliminates the need for selective assembly ordinarily required to obtain no-clearance fits. The principle also permits compensation for any wear that may develop eventually in severe applications.

## OPEN Series "OPN"

*1/2" thru 4"*



SEE  
PAGES  
12 & 13

Open Type Series OPN BALL BUSHINGS have a longitudinal section removed from their circumference, to permit the use of shaft support members along the length of the shaft which they traverse.

This construction eliminates shaft deflection and is recommended where extreme rigidity or unusually long shafts are a requirement. The principle also permits diameter adjustment and compensation for any wear that may develop eventually in severe applications.

## DIE SET Series "DS"

*1" thru 2"*



SEE  
PAGES  
14 & 15

For many years BALL BUSHINGS have provided industry with the long-needed solution of linear motion problems. BALL BUSHING utilization in die sets, however, has been limited by the fact that they could not be readily installed in place of sleeve-type die set bushings without modification of the punch holder. This limiting condition has now been removed by the development of the THOMSON Die-Set BALL BUSHING.

# 22 ADVANTAGES

**Use of Ball Bushings is the low cost way of obtaining these results:**

**LOW FRICTION** — In addition to high friction due to sliding, plain bushings tend to bind or stick from the adherence of dust particles to the lubricant which must be present on the shaft. With BALL BUSHINGS, starting loads are light as they are unaffected by "squeeze out" of the oil film during the static conditions. Friction under all conditions is reduced to the absolute minimum.

**DESIGN ECONOMIES** — BALL BUSHINGS are considerably less expensive than bulky wheel and track arrangements and when used to replace V-ways, tremendous cost savings are obtainable in addition to the operating advantages. When substituted for plain bushings, it is frequently possible to scale down the size, weight and cost of the entire mechanism.

**LASTING PRECISION ALIGNMENT** — Super-accurate, true-running linear motions can be obtained and maintained. Loss of precision resulting from rapid wear of close fit plain bushings or V-ways is eliminated — an important factor where lasting accurate support is required in tooling and various precision machines and mechanisms.

**ELIMINATE BINDING AND CHATTER** — The vibration and chatter which is caused by and plagues the operation of plain sliding bushings is completely eliminated by the free rolling BALL BUSHING principle.

**SOLVES SLIDING LUBRICATION PROBLEMS** — Obviously a rolling ball requires much less lubrication than sliding surfaces. Where desired, seals can be used in combination with BALL BUSHINGS which will retain adequate lubricant for long operating life. The design difficulty of getting lubricant to and maintaining it on plain sliding bearings is eliminated.

**CLEAN COMPACT DESIGN** — Neat appearing, efficient mechanisms can be designed by supporting linear motions on BALL BUSHINGS. Their free rolling characteristics permit short bushing lengths. Removal of minimum length limitations for plain bushings, or the bulkiness of other arrangements, enables startling design possibilities for dimensional reduction and appearance improvement.

**LONG LIFE** — Oil is forced out of plain bearings during the static conditions, destroying the film on which their operating effectiveness depends. The rolling ball eliminates this serious cause of wear.

**ZERO SHAKE OR PLAY** — Shake or lateral play on linear motions can be eliminated when using BALL BUSHINGS by using Adjustable Diameter or Open Type BALL BUSHINGS, or by other methods described on Page 9.

**REDUCED MAINTENANCE** — BALL BUSHINGS give long, trouble-free service at economical cost. Frequent expensive replacement of plain bearings or scraping of ways is eliminated.

**MECHANISM RELIABILITY** — Practically frictionless, free rolling, non-wear characteristics of BALL BUSHINGS preclude expensive shut-downs that occur when a plain bushing suddenly seizes up. No adjustment, repair or attention is necessary.

**HIGHER OPERATING SPEEDS** — Greater production and efficiency can frequently be obtained by application of BALL BUSHINGS when heat generation and wear of plain sliding bearings is a limiting factor.

**NO RUN-OUT** — Properly mounted BALL BUSHINGS will follow their shaft with mathematically perfect accuracy. There can be no accumulation of tolerances to cause waviness — an important feature in many precision mechanisms.

**COMPONENT ECONOMIES** — The low starting and running friction imparted to linear motions by BALL BUSHINGS allows the use of smaller, less expensive drive motors, belts, linkages, gears, etc.

**LESS SERVICING** — The price of continual vigilance and the required frequent oiling of plain sliding bearings is usually surprising if isolated. BALL BUSHINGS again save here, *plus* the cost of the lubricant — a considerable factor.

**INCREASED MACHINE LIFE** — BALL BUSHINGS eliminate heavy initial starting strains resulting from destruction of the oil film in plain bushings during idleness. Such severe loads materially shorten the life of motors, gears, belts, linkages and other parts. All parts associated with BALL BUSHINGS benefit from their use.

**CONSTANT FRICTION COEFFICIENT** — Variations in the load on BALL BUSHINGS do not appreciably affect the extremely low friction coefficient as in the case of plain bearings. In addition, changes in viscosity of lubricants, due to temperature or other causes, have little comparable effect on the BALL BUSHINGS. These can be important advantages.

**CLEANLINESS** — In many applications it is undesirable to have oil or grease on shafts for linear motion. The true rolling action of BALL BUSHINGS demands far less lubrication than sliding surfaces. The mess and hazard of dripping lubricant is therefore eliminated.


**POWER SAVINGS** — Friction consumes a shocking proportion of the power input to most mechanisms — particularly where sliding occurs. Just the savings in electric power or man power usually make BALL BUSHINGS an excellent investment.

**COMPACTNESS** — BALL BUSHINGS have an outside diameter very little larger than most plain bushings. This permits their substitution in many existing designs without modification of parts.

**UNIT CONSTRUCTION** — Balls are retained in their tracks and will not fall out when the BALL BUSHING is removed from the shaft. This permits ease of handling and high production assembly.

**UNLIMITED TRAVEL** — The simple and unique principle of recirculating the balls removes all limitation on the length of the anti-friction stroke.

**CONSUMER ACCEPTANCE** — *last but by far not the least if your product is used by others!* The many advantages of ball bearings have created their universal acceptance and identification with "better products". The BALL BUSHING now brings this tremendous advantage to you.



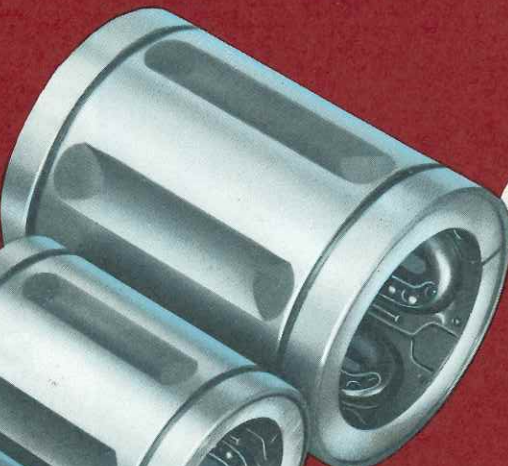
**Series "DS"**  
1" thru 2"



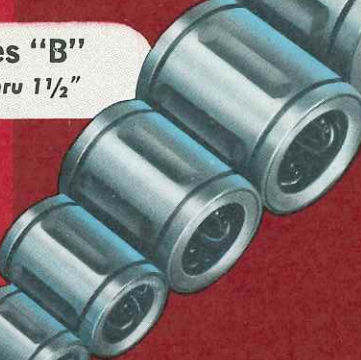
Linear-Rotary  
**"Combination"**  
(All sizes)



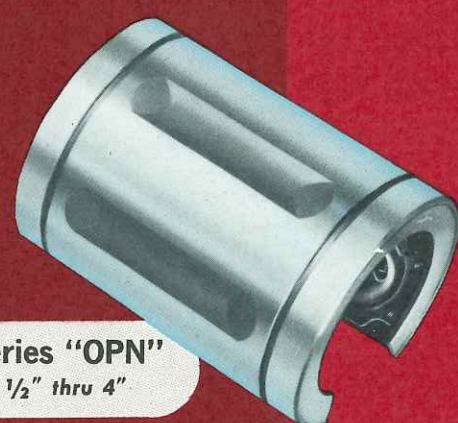
**Series "ADJ"**  
 $\frac{1}{2}$ " thru 4"




**Series "A" "XA"**  
 $\frac{1}{4}$ " thru 4"



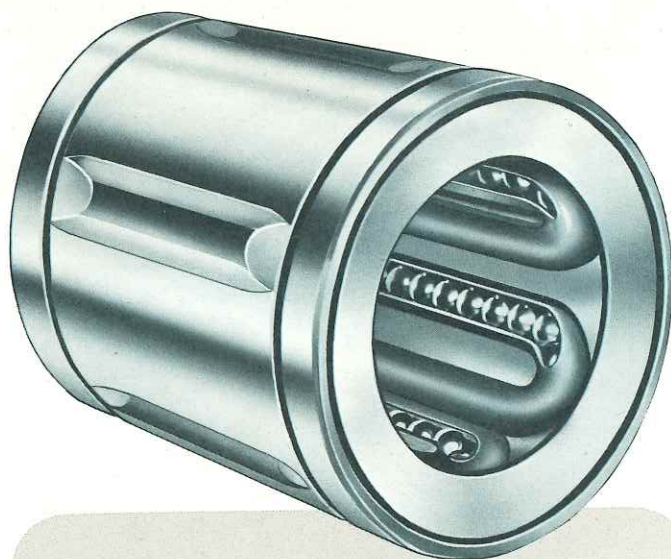
**Series "B"**  
 $\frac{1}{4}$ " thru 1 $\frac{1}{2}$ "



**Series "OPN"**  
 $\frac{1}{2}$ " thru 4"



**Series "INST"**  
 $\frac{1}{8}$ " thru  $\frac{1}{4}$ "



**Offer you these important benefits:**

- ✓ **LOW FRICTION and WEAR**
- ✓ **LASTING PRECISION ALIGNMENT**
- ✓ **ELIMINATE BINDING and CHATTER**
- ✓ **ZERO SHAKE or PLAY**
- ✓ **LONG LIFE**
- ✓ **LOW MAINTENANCE**
- ✓ **SOLVE SLIDING**
- LUBRICATION PROBLEMS**
- ✓ **CONSTANT FRICTION COEFFICIENT**
- ✓ **ELIMINATE STICK-SLIP**
- ✓ **HIGHER OPERATING SPEEDS**
- ✓ **CLEAN COMPACT DESIGN**

Series A, XA and B BALL BUSHINGS are the simplest form of the BALL BUSHING. They afford the economies of installation by press fitting or other arrangements described on the following page.

The Series A Precision BALL BUSHINGS are normally used in applications where close fits are required but in which a small amount of play is permissible.

Series XA Super-Precision BALL BUSHINGS have an extremely close bore tolerance and are normally used where a higher degree of precision is required. Both the Series A and Series XA can be used for "no play" applications by selective assembly as described under "Line-to-Line Fits."

The Commercial Grade Series B BALL BUSHING is manufactured only in the smaller sizes ( $\frac{1}{4}$ " thru  $1\frac{1}{2}$ " I.D.) for low cost, large volume applications where high precision is not essential.

For engineering data and other details refer to Page 27.

## Series "A, XA, & B" BALL BUSHINGS — INSTALLATION DATA

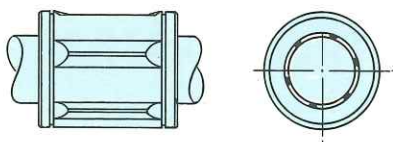
**Ball Bushings are easy to install but a simple procedure should be used to avoid interference fits.**

BALL BUSHINGS may be retained in the housing hole by a Press Fit or a Push Fit in combination with several retaining means suggested on the following page. If seals are used in the installation, a Push Fit BALL BUSHING can be retained by the Press Fit of the seal unit as suggested on page 19.

A Press Fit is perhaps the simplest way to retain a BALL BUSHING, but care must be exercised to avoid too tight a press as this could reduce the working bore of the bearing with resulting damage to the shaft or BALL BUSHING. A *light* press should be used and is all that is required since very little longitudinal force can be imparted to the bearing due to its free rolling characteristics. In *no event* should the housing bore be *any smaller* than the minimum recommended press fit housing diameter shown on Page 27.

Two BALL BUSHINGS are usually used in tandem unless the cocking loads are very light or shaft alignment is otherwise maintained. If a close fit shaft is used or the bearings are expected to carry an appreciable load, the alignment of the two BALL BUSHINGS is very important. To insure this, the mounting holes should be *bored straight* and *after* all other machine work on the housing is finished. When this is not practical, individual BALL BUSHING mounting blocks are recommended to permit precise alignment.

Another important precaution in installing BALL BUSHINGS is the avoidance of excessive pre-load fit between the shaft and the working bore (inside diameter) of the bearing. This can be caused by using a shaft having too large a diameter or by reducing the working bore by too tight a Press or Clamp Fit. Misalignment will also produce the same effect. An interference fit from any of these causes can be simply checked. With the *bearings finally mounted in the housing* and on the shaft, and with the lightest possible load on the bearings, it should be possible to *freely rotate* the shaft relative to the bearings with a *light* finger pressure. If it does not turn smoothly and easily and the bearings seem to grip the shaft, check immediately and before operation for: too large a shaft diameter; too tight a Press or Clamp Fit in housing; misalignment of BALL BUSHINGS.

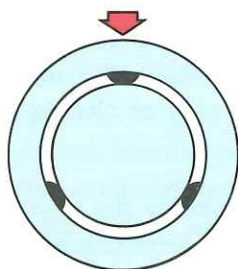


### Line-to-line fits

If Adjustable Diameter or Open Type BALL BUSHINGS described on Pages 10 thru 13 are not used, it is possible to obtain line-to-line or slightly pre-loaded fits by either of the following methods:

Line-to-line or slightly pre-loaded fits may be obtained by using Series A or XA BALL BUSHINGS, by selectively fitting shafts having varying diameters within the bearing bore tolerance to the BALL BUSHINGS *after they have been finally installed in the housing*. This is important to eliminate the effect of any misalignment or changes in I.D. due to press fitting. If the shaft cannot be rotated freely with a light finger pressure excessive interference exists. The shaft should be removed and a smaller shaft substituted.

Another method which can be used only with the three-track  $\frac{1}{4}$ " BALL BUSHINGS is to distort the I.D. by exerting pressure through a screw or some other clamping device in the indent directly above one row of balls as shown in Fig. 2. Care must be used to avoid introducing excessive pre-loads which will cause rough operation and possible damage to Bushing or shaft. Make sure that shaft rotates freely by hand after adjustment.



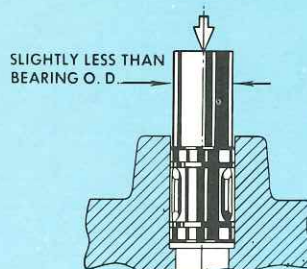
**Fig. 2** — Slightly distort Bushing I.D. by exerting set screw pressure in indent at this point to produce line-to-line fit. *Three-track BALL BUSHINGS only.*

For engineering specifications see Page 27. For prices refer to Price Sheet inserted inside back cover. If additional information is required contact your local representative whose name is shown on back cover . . . or phone or write factory direct.

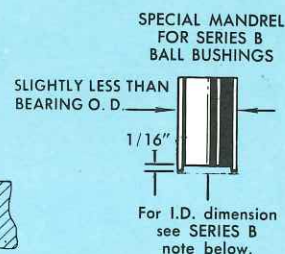


STANDARD THOMSON 60 CASE SHAFTING IS  
RECOMMENDED FOR USE WITH BALL BUSHINGS.

## Series "A, XA, & B"



**Fig. 3a**



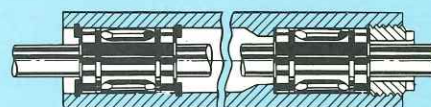
**Fig. 3b**

**Fig. 3a—Press Fitting Series A Ball Bushings**

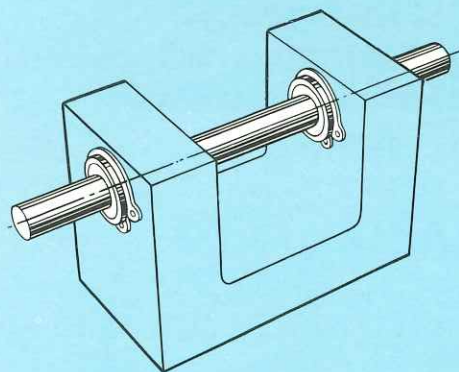
Axial pressure should be applied only at the outer periphery of the bearings by use of a *flat ended* round tool having a diameter slightly less than the O.D. of the bearing. Too tight a Press Fit must be avoided.

**Fig. 3b—Press Fitting Series B Ball Bushings**

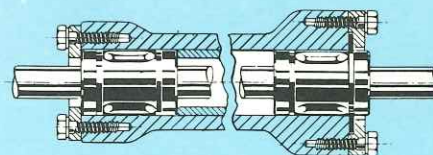
To press fit Series B BALL BUSHINGS it is necessary to use a special mandrel as shown at right above to avoid exerting pressure on the protruding end ring. This mandrel should be hardened. I.D. of the mandrel recess for the various Series B sizes is as follows:  $\frac{1}{4}$ "—.460" min.;  $\frac{3}{8}$ "—.585" min.;  $\frac{1}{2}$ "—.800" min.;  $\frac{3}{4}$ "—1.150" min.; 1"—1.475 min.;  $1\frac{1}{4}$ "—1.843" min.;  $1\frac{1}{2}$ "—2.000" min.



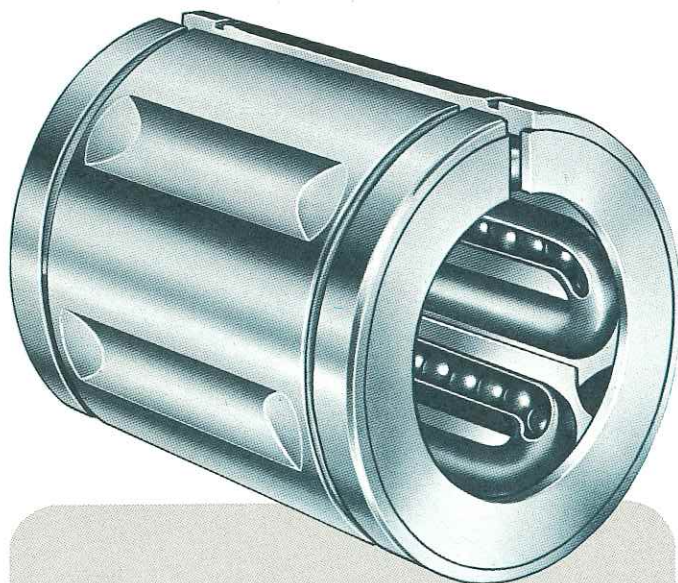
**Fig. 4—Simple Installations** A Push Fit bearing secured in a through bored hole between snap rings (left), or in a shallow bored hole between an internal shoulder and a threaded plug (right).



**Fig. 5—External Retaining Ring Installation** BALL BUSHING may be simply retained in a Push Fit housing bore by use of either Type W or Type C external retaining rings in the retaining ring grooves on the Bushing O.D.



**Fig. 6—Use of Cover Plates** A Push Fit bearing secured in a through-bored hole between an inner spacer sleeve and a cover plate (left), or by means of an external snap ring retained by a cover plate (right).

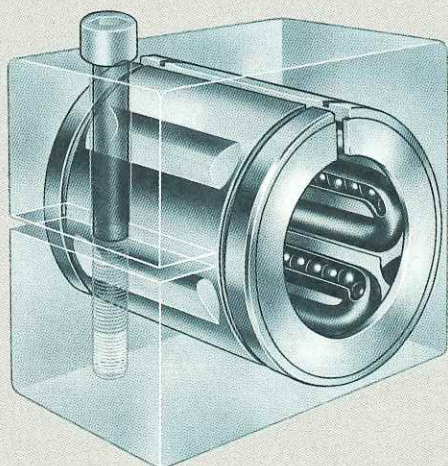


## Series "ADJ" ADJUSTABLE DIAMETER BALL BUSHINGS — INSTALLATION DATA

**A zero clearance Ball Bearing  
for your linear motions**

**Offer you these important benefits:**

- ✓ **ZERO SHAKE or PLAY**
- ✓ **ADJUSTABLE for WEAR**
- ✓ **NO SELECTIVE ASSEMBLY**
- ✓ **NO BINDING or CHATTER**
- ✓ **VERY LOW FRICTION**
- ✓ **LASTING PRECISION ALIGNMENT**
- ✓ **SOLVE LUBRICATION PROBLEMS**
- ✓ **ELIMINATE STICK-SLIP**
- ✓ **LONG LIFE**
- ✓ **CONSTANT FRICTION COEFFICIENT**
- ✓ **POWER SAVINGS**
- ✓ **HIGHER OPERATING SPEEDS**
- ✓ **REDUCE MAINTENANCE**



*Adjustable Diameter BALL BUSHINGS* are split longitudinally and designed to *easily* provide line-to-line or slight pre-load fits when mounted in adjustable diameter housings.

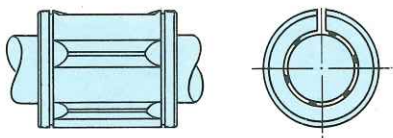
This construction eliminates the need for selective assembly ordinarily required to obtain no-clearance fits because of the tolerances on the housing bore, bearing bore and shaft diameter. The principle also permits compensation for any wear which may eventually develop in severe applications.

The long sought objective of free-running, no-play linear motion is now a practical and simple matter with the proper application of Adjustable Diameter BALL BUSHINGS. This characteristic can be used to great advantage in many applications such as machine tools, special machinery and tooling, electronic equipment, gauges and instrumentation and many other linear motions where shake, play or chatter is detrimental.

There are many ways to provide the adjustable diameter housing. A few simple arrangements are suggested here. Many more, equally satisfactory, can be designed to meet the requirements of the individual application.

IT IS RECOMMENDED THAT SLOT IN BALL BUSHING BE LOCATED 90° FROM SLOT IN HOUSING.

Individual BALL BUSHING mounting blocks are normally recommended for use with Adjustable Diameter BALL BUSHINGS to permit precise adjustment and alignment of BALL BUSHINGS to shafts.



### Diameter adjustment

A slight amount of BALL BUSHING preload is usually permissible in most applications, particularly with the larger sizes. However, care must be exercised to avoid excessive preload when adjusting the bore diameter. Excessive preload will cause rough operation and may damage the bearing or shaft surface. (Slight shaft grooving will not impair the operation of the BALL BUSHING.)

The simplest method of obtaining proper adjustment for line-to-line or slight preload fits is to feel the freedom of *rotation* between the BALL BUSHING and shaft. The bearing should be loosened to allow free rotation and then gradually tightened until it starts to grip the shaft. The tightening should be *stopped as soon as an increase* in the force required to turn the shaft is felt. This indicates a line-to-line or slight preload fit.

In tandem arrangements, one bearing should be adjusted with the other one loose. The position of its adjusting screws (i.e., 10:o'clock, 2:o'clock etc.) or a torque wrench reading should then be noted. It may then be loosened and the second bearing adjusted. The first bearing is then returned to its proper setting.

For engineering specifications see Page 28. For prices refer to Price Sheet inserted inside back cover. If additional information is required contact your local representative whose name is shown on back cover . . . or phone or write factory direct.



STANDARD THOMSON 60 CASE SHAFTING IS  
RECOMMENDED FOR USE WITH BALL BUSHINGS.

## Series "ADJ"

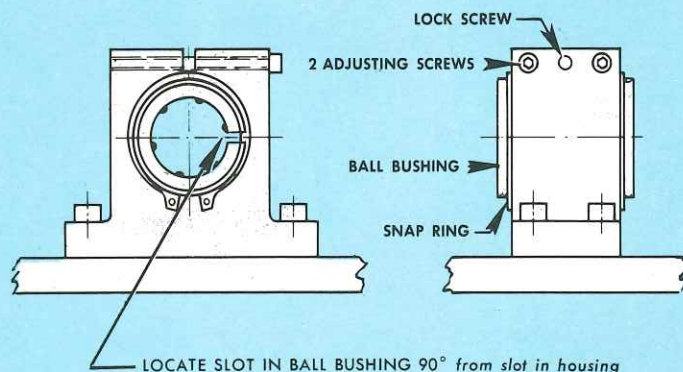


Fig. 7—Pillow Block Mount with Double Adjusting Screw

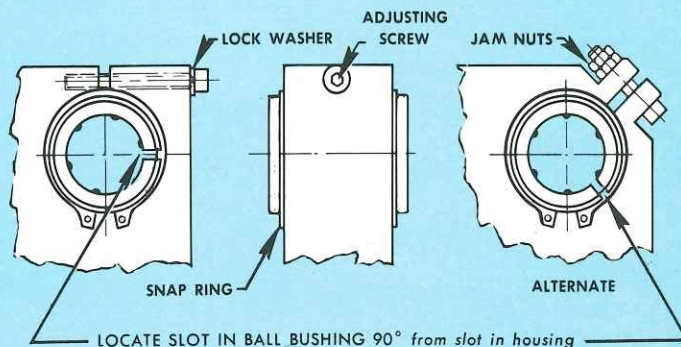


Fig. 8—Plate Type Mounts with Single Adjusting Screw

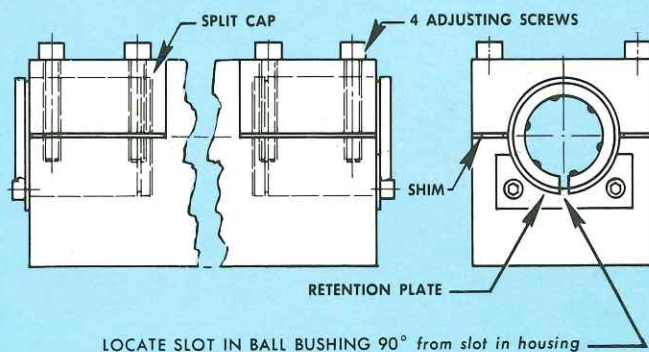
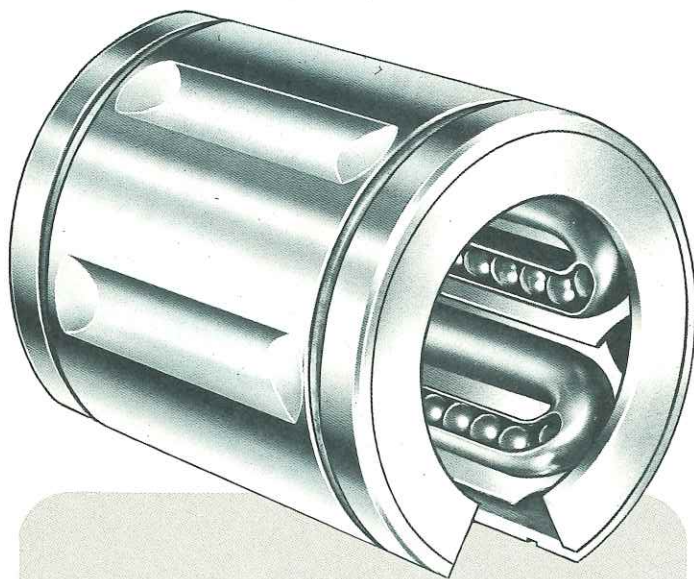


Fig. 9—Tandem Arrangement with Adjustable Caps

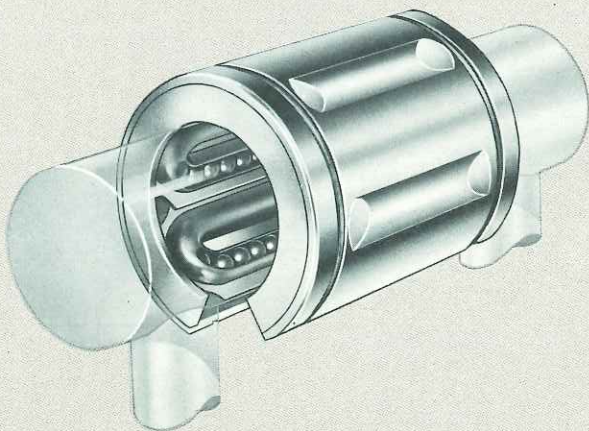


## Series "OPN" OPEN TYPE BALL BUSHINGS — INSTALLATION DATA

*A zero clearance linear Ball Bearing  
for supported shafts*

**Offer you these important benefits:**

- ✓ PREVENT SHAFT DEFLECTION
- ✓ PERMIT LONGER SHAFTS
- ✓ PROVIDE ANTI-FRICTION WAYS
- ✓ ZERO SHAKE or PLAY
- ✓ ADJUSTABLE for WEAR
- ✓ COST SAVING OVER  
FLAT or V-WAYS
- ✓ PERMIT SMALLER DIAMETER SHAFTS
- ✓ NO BINDING or CHATTER
- ✓ VERY LOW FRICTION
- ✓ ELIMINATE STICK-SLIP
- ✓ LASTING PRECISION ALIGNMENT
- ✓ SOLVE LUBRICATION PROBLEMS
- ✓ LONG LIFE
- ✓ CONSTANT FRICTION COEFFICIENT
- ✓ POWER SAVINGS
- ✓ HIGHER OPERATING SPEEDS
- ✓ REDUCE MAINTENANCE
- ✓ CLEAN COMPACT DESIGN



*Open Type* BALL BUSHINGS have a longitudinal section removed from their circumference, to permit the use of shaft support members along the length of the shaft which they traverse. The *standard* Open Type have an open sector equal to one ball circuit. The width of the open sector can be increased on special orders by omitting additional ball circuits.

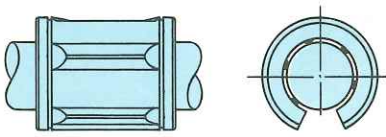
This construction eliminates shaft deflection and is recommended where extreme rigidity or unusually long shafts are a requirement. The principle also permits compensation for any wear which may eventually develop in severe applications.

The long sought objective of free-running, no-play linear motion, rigidly supported, is now a practical and simple matter with the proper application of Open Type BALL BUSHINGS. The combination of Open Type BALL BUSHINGS and supported shafts now provides inexpensive precision anti-friction ways.

In addition to the economies of using centerless ground round shafts for ways, the low friction, lasting alignment and freedom from chatter of BALL BUSHINGS are important basic considerations in machine design. The provision for adjusting for zero shake or play and for possible subsequent wear is also important and is being used by alert designers who formerly had to use plain sliding flat- or V-ways.

There are many types of housings and shaft supports which may be used with Open Type BALL BUSHINGS. A few arrangements are suggested here. Many more, equally satisfactory, can be designed to meet the requirements of the individual application.

When no-play, line-to-line or slight preload fits are desired, provision should be made to permit adjusting the



BALL BUSHING bore diameter. A few methods by which this may be accomplished are illustrated.

Individual BALL BUSHING mounting blocks are normally recommended for use with Open Type BALL BUSHINGS to permit precise adjustment and alignment of BALL BUSHINGS to shafts.

It is usually desirable, particularly when shafts are to be supported on an uneven base, to provide adjustable supports to enable accurate alignment of the shafts with each other. A few adjustable type shaft supports are illustrated.

### Diameter adjustment

A slight amount of BALL BUSHING preload is usually permissible in most applications, particularly with the larger sizes. However, care must be exercised to avoid excessive preload when adjusting the bore diameter. Excessive preload will cause rough operation and may damage the bearing or shaft surface. (Slight shaft grooving will not impair the operation of the BALL BUSHING.) *The adjusting procedure described for the Adjustable Diameter BALL BUSHING under "DIAMETER ADJUSTMENT" should be carefully followed.*

### Retaining rings

Standard C-type retaining rings, as well as other methods, may be used with Open Type BALL BUSHINGS as suggested in the illustrations.

*For engineering specifications see Page 28. For prices refer to Price Sheet inserted inside back cover. If additional information is required contact your local representative whose name is shown on back cover . . . or phone or write factory direct.*



STANDARD THOMSON 60 CASE SHAFTING IS  
RECOMMENDED FOR USE WITH BALL BUSHINGS.

## Series "OPN"

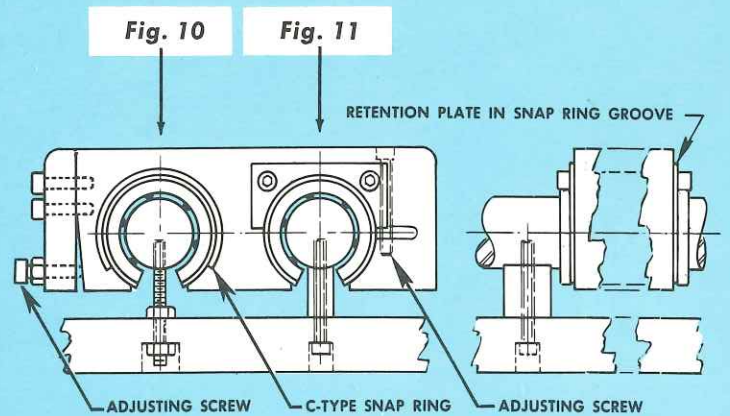


Fig. 10  
Stud Type Mount

Fig. 11  
Pillar Type Shaft Mount

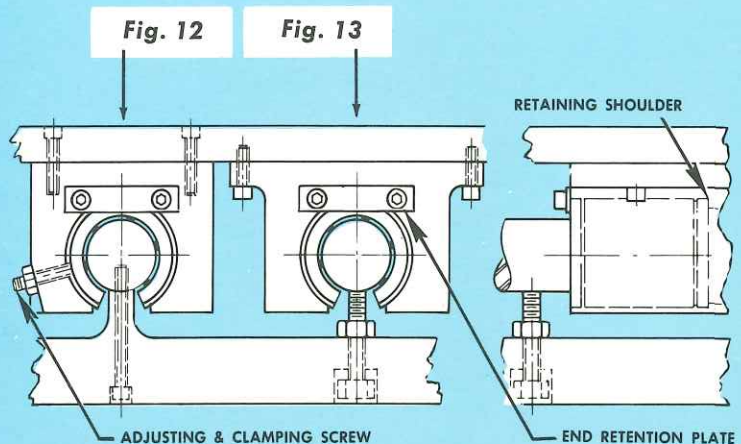


Fig. 12  
Boss Type Shaft Mount

Fig. 13  
Screw Type Shaft Support

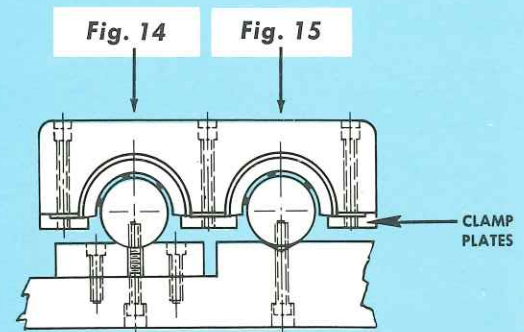


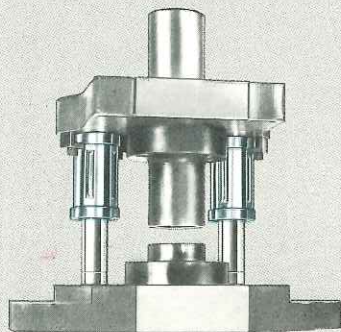
Fig. 14  
Gib Type Shaft Mount

Fig. 15  
V-Groove Shaft Mount



**Offer you these important benefits:**

- ✓ **BETTER DIES**
- ✓ **REDUCED TOOLING TIME**
- ✓ **REDUCED TOOLING COST**
- ✓ **LESS DIE SHARPENING**
- ✓ **NO COCKING or BINDING**
- ✓ **INCREASED DIE LIFE**
- ✓ **LONGER PRESS RUNS**
- ✓ **HIGHER PRESS SPEEDS**
- ✓ **INCREASED PRODUCTION**
- ✓ **LOWER UNIT COST**
- ✓ **SEIZURE ELIMINATION**
- ✓ **REDUCED LUBRICATION**
- ✓ **UNLIMITED STROKE LENGTH**
- ✓ **STANDARD SIZES**
- ✓ **SIMPLE REPLACEMENT**



## **Series "DS"**

### **Interchangeable DIE-SET**

### **BALL BUSHINGS —**

### **INSTALLATION DATA**

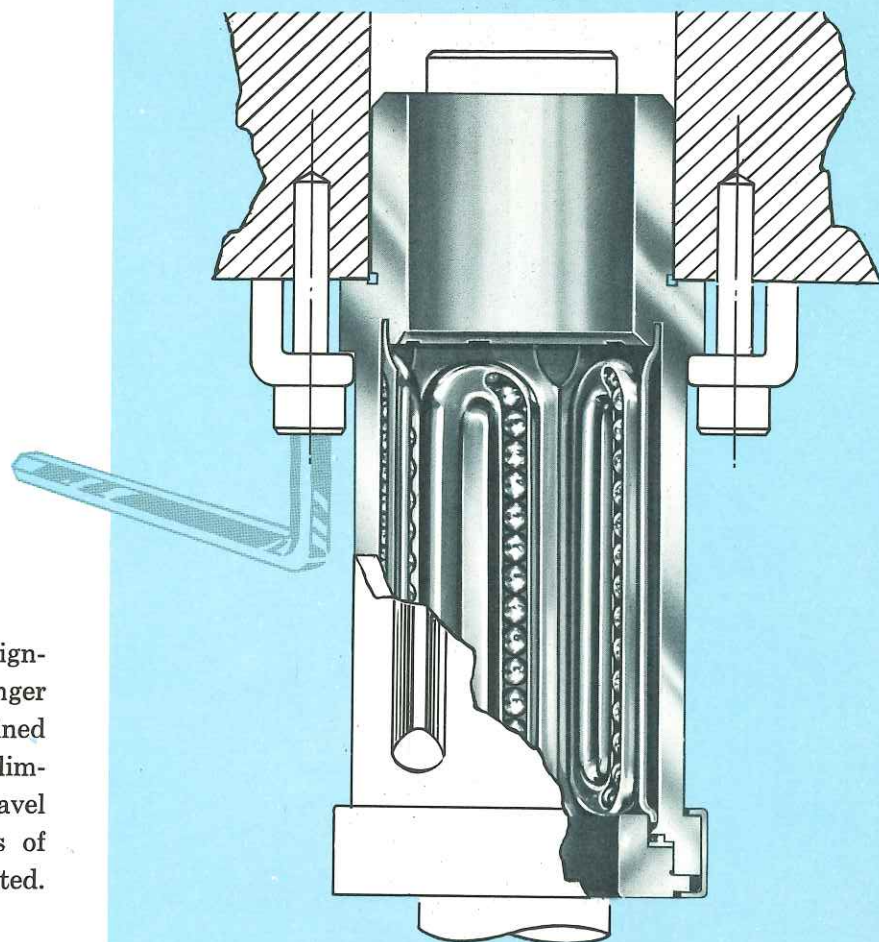
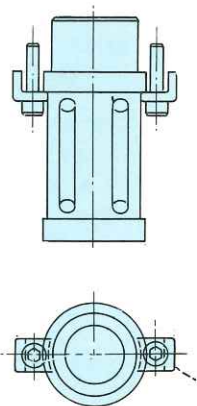
**A direct Ball Bushing replacement  
of ordinary sleeve-type bushings**

This simple Bushing replacement... 1) improves performance of present dies and, 2) reduces tool room costs.

For many years BALL BUSHINGS have provided industry with the long-needed solution of linear motion problems. BALL BUSHING utilization in die sets, however, has been limited by the fact that they could not be readily installed in place of sleeve-type die set bushings without modification of the punch holder. This limiting condition has now been removed by the development of the THOMSON Die-Set BALL BUSHING.

This new Die-Set BALL BUSHING was designed specifically to fit the mounting holes in the punch holder of standard die sets. Each D-S BALL BUSHING is supplied with the required number of toe clamps and socket head screws for immediate interchange. Other features include extremely rugged construction and additional load capacity and travel life.

A description of the Operating Principle of BALL BUSHINGS is given on Page 3. This new Die-Set BALL BUSHING now makes it possible for both manufacturers and users of die sets to obtain the recognized advantages of BALL BUSHINGS. Die costs represent a major investment. The slight extra cost of "going ball bearing" is negligible.



### Advantages in the Press Room

BALL BUSHINGS allow closer fits and maintain alignment... which increases die life and permits longer uninterrupted runs. Fewer sharpenings and sustained parts accuracy also result. Periodic lubrication is eliminated and higher speeds are possible. Unlimited travel permits die to be used in any press regardless of stroke. Costly smash-ups due to seizure are eliminated.

### Advantages in the Tool Room

No cocking and binding... hence the punch holder "floats" on and off! No time-consuming die jacking! Free-rolling ball bearings enable the toolmaker to actually "feel in" the fit of mating parts. This saves more time and makes better dies.

*For engineering specifications see Page 29. For prices refer to Price Sheet inserted inside back cover. If additional information is required contact your local representative whose name is shown on back cover... or phone or write factory direct.*

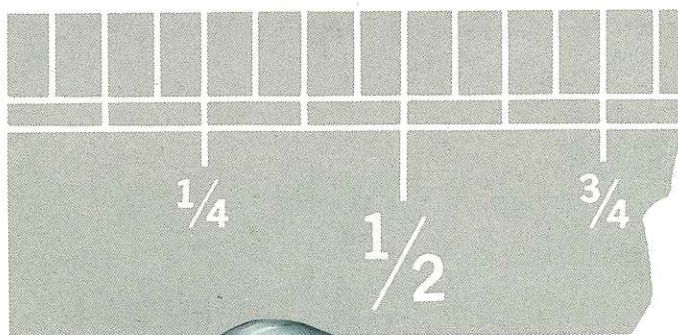


STANDARD THOMSON 60 CASE SHAFTING IS  
RECOMMENDED FOR USE WITH BALL BUSHINGS.

## GO ANTI-FRICTION

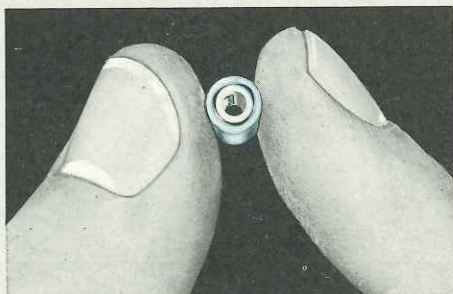
with a simple bushing replacement

- and **1** Improve performance  
of your present dies
- and **2** Reduce tool room costs



**Offer you these important benefits:**

- ✓ **EXTREMELY SMALL SIZE**
- ✓ **SUPERSENSITIVE LINEAR MOVEMENT**
- ✓ **LIGHTEST WEIGHT**
- ✓ **UNLIMITED TRAVEL**
- ✓ **MINIMAL FRICTION COEFFICIENT**
- ✓ **ZERO SHAKE OR PLAY**
- ✓ **MINIMAL POWER REQUIREMENT**
- ✓ **LONG LIFE**
- ✓ **MINIMAL NOISE LEVEL**
- ✓ **NO BINDING OR CHATTER**
- ✓ **MINIMAL INERTIAL LOAD**



## **Series "INST"** **INSTRUMENT** **BALL BUSHINGS —** **INSTALLATION DATA**

### ***A Supersensitive Linear Ball Bearing for Instrumentation***

The urgent demand by the military for the utmost in component miniaturization and sensitivity has resulted in new manufacturing techniques which for the first time enable the production of extremely miniscule *linear* ball bearings. This important break-through with a vital component will enable major reductions in both the size and weight of critical instruments and accessories.

These new instrument quality BALL BUSHINGS are for use on shaft diameters of  $\frac{1}{8}$ ",  $\frac{3}{16}$ " and  $\frac{1}{4}$ ". Each bearing contains three complete ball circuits. Although smaller in size, the  $\frac{1}{8}$ " and  $\frac{3}{16}$ " Bushings possess all the supersensitive characteristics of the larger  $\frac{1}{4}$ " I.D. (INST-4812-SS) Instrument Bushing. They are extremely rugged in construction and capable of withstanding high vibrational and shock loads. The precision manufacturing techniques, combined with the anti-friction rolling design, assure minimum static and rolling friction and a high degree of reliability and repeatability.

The use of these Bushings, in place of ordinary friction-type sleeve bearings, provides optimum performance characteristics. Applications are: the latest *guidance, fire control and navigation systems, computers, inertial devices, instruments*.

Instrument BALL BUSHINGS consist of three basic parts: an outer sleeve, balls and a ball retainer. All parts are precision machined and then individually inspected for both surface finish and dimensions. Each bearing is also individually tested for sensitivity.

Where required, shafts having a surface finish of 2-4 rms. are supplied, individually fitted to Bushings to provide clearance of .0001" minimum and .0003" maximum. Shaft material is *stainless steel*.

## Friction Test

These bearings are 100% inspected at the factory for friction as well as dimensional accuracy. The criterion of friction is the angle of a shaft down which they will continuously roll. The bearings are oriented with one ball track at the top of the shaft.

Under clean conditions with one working track positioned directly under the load the Instrument BALL BUSHING will roll down a shaft angle of 14 minutes ( $\frac{1}{4}$  degree) with only a three-ounce load. The coefficient of friction under this very light load is 0.004. Under heavier loads the coefficient of friction is even less, as illustrated in the graph below.

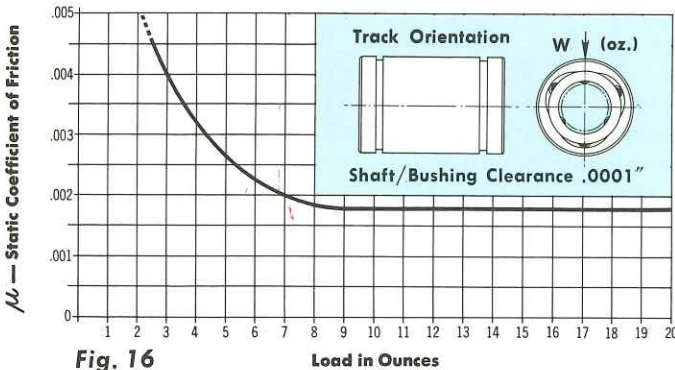


Fig. 16

## Bore Measurement

Rotate with light finger pressure on a series of plug gauges ranging in diameter from the nominal working bore diameter to the tolerance limit of *minus* .0003". These plugs should take the tolerance range in .0001" steps; in other words, a total of 4 plug gauges for each bushing. When a slight drag or "feel" is experienced a slight interference fit has developed and the bearing should be coded for use on a shaft having a diameter at least .0001" smaller than the plug gauge. An interference fit must be avoided or roughness and possible damage will result.

## Cleaning

As in the case of any instrument quality bearing, absolute cleanliness is of utmost importance. These bearings have been assembled, cleaned, tested and packed in clean cabinets in an atmosphere of filtered air. It is recommended that installation also be conducted under similar conditions.

You will note that there are through passages between the retainer and the outer sleeve. These permit cleaning solvent to be blown through and the escape of dust particles from the outside of the retainer as well as from the inside. Only cleaning solvent leaving no film or deposit should be used.



For engineering specifications see Page 29. For prices refer to Price Sheet inserted inside back cover. If additional information is required contact your local representative whose name is shown on back cover . . . or phone or write factory direct.

# SHAFTS for use with Instrument Ball Bushings.

For optimum sensitivity it is generally recommended that shafts hardened to Rockwell 55 to 60C, and having a surface finish of approximately 2-4 rms., be selectively fitted to BALL BUSHINGS to provide clearance of .0001" minimum and .0003" maximum.

Matched sets of BALL BUSHINGS with Shafts fitted to provide minimum clearance are available from THOMSON INDUSTRIES for applications in which extreme sensitivity is a requirement. To obtain quote, advise quantity required, length, and details of any special machining.

## Precision Instrument Shafts (1/8", 3/16" & 1/4")

LENGTH TOLERANCE:.....  $\pm .005"$ .

CHAMFER:..... .01" x 45° (both ends).

DIAMETER TOLERANCE:.... .0001" shafts up to 6" long.

MATERIAL:..... 440C Stainless Steel.

HARDNESS:..... 55-60C (stabilized by deep freezing).

STRAIGHTNESS:..... .0001" per inch of length.

SURFACE FINISH:..... Lapped to 4 microinch (rms). or better.

DIAMETER:..... Shafts for general use can be supplied to specific dimensions within the diameter range of nominal to *minus* .0006" provided the above listed tolerances are used.

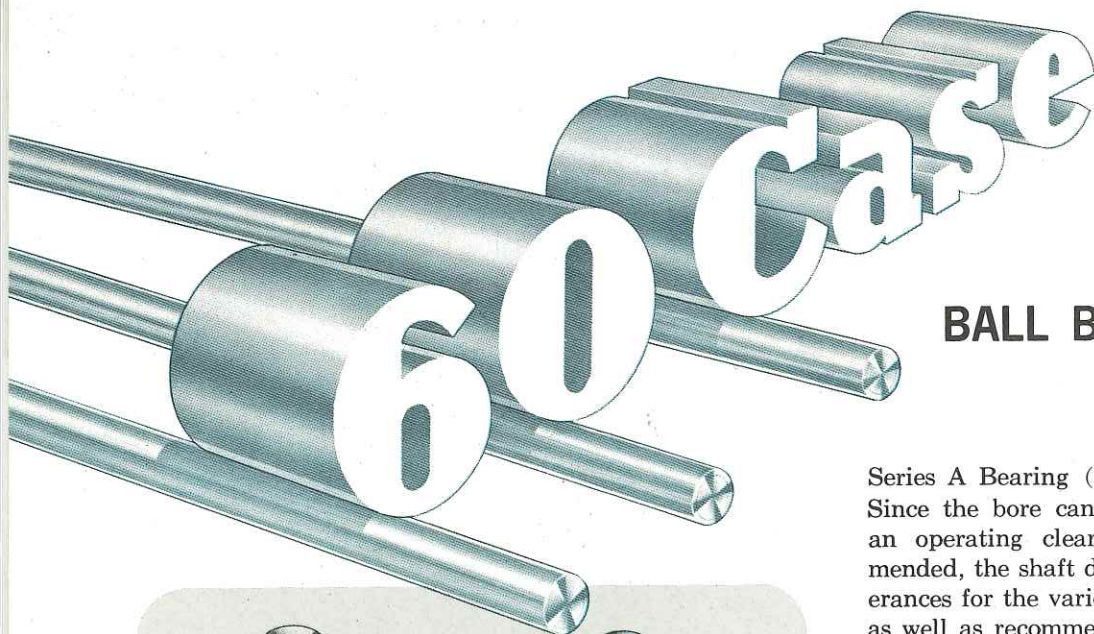
LENGTH:..... The maximum standard length is 12 inches. Longer lengths are special.

## Special Machining

These shafts can be specially machined to suit individual requirements of mounting or use. Inasmuch as they are stocked in hardened and ground lengths, the shafts are most readily modified by simple secondary grinding operations. Such things as reduced diameters, snap ring grooves, flats and special chamfers can be done this way. It is generally to the customer's advantage to limit his special machining to these operations if at all possible. However, by locally annealing the shaft, features such as drilling and tapping can be accomplished.

## Recommendations

For optimum performance the clearance between shaft and BALL BUSHING should be at least .0001". An interference fit must be avoided or roughness and possible damage will result. In applications where interchangeability is desired, the selection of the proper shaft size will result in a clearance range of .0001" to .0005" without the necessity of selective assembly. Where closer operating clearances are required, matched sets of Bushings and shafts can be supplied which will provide clearances of .0001" minimum to .0003" maximum.



## BALL BUSHING SHAFTS



**Standard Ball Bushing shafting is available. If you prefer to make your own shafts, be certain the maximum recommended diameter is not exceeded.**

- The shaft on which BALL BUSHINGS operate acts as the inner bearing race. To assure a long service life, for all but lightly loaded applications, the shaft should be hardened to Rockwell 58 to 63C to an adequate depth. In order to provide smooth operation and the required degree of precision, it should be smooth, round and straight. THOMSON hardened and ground 60 Case shafts are manufactured for this specific purpose on equipment especially designed by THOMSON INDUSTRIES, INC. This material is of extremely high quality and fills all of these requirements. It is carried in stock for immediate shipment and is supplied cut to the required length with or without special machining.

- If you prefer to make your own shafts, care should be exercised to obtain the proper hardness and not to exceed the maximum permissible diameter. Because of the tolerance on the bore diameter of BALL BUSHINGS, the shaft diameter should *always* be smaller than the nominal dimension. For example, the bore diameter of the  $\frac{1}{2}$ " Shaft

Series A Bearing (A81420) is  $.5000" + .0000" - .0005"$ . Since the bore can therefore go as small as  $.4995"$  and an operating clearance of  $.0005"$  is generally recommended, the shaft diameter should *not exceed*  $.4990"$  Tolerances for the various sizes and types of BALL BUSHINGS as well as recommended shaft diameters can be obtained from Pages 27 thru 30.

In applications where no looseness or play is permissible, Adjustable Diameter BALL BUSHINGS are generally used. However, if they are not used, line-to-line fits may be obtained with Series A or Series XA BALL BUSHINGS by selectively fitting shafts having varying diameters within the bearing bore tolerance to the BALL BUSHINGS after they have been finally installed in the housing. This is important in order to eliminate the effect of any misalignment or changes in I.D. due to press fitting. If the shaft cannot be rotated freely with a light finger pressure, an interference fit exists. The shaft should then be removed and a smaller shaft substituted.

- Hardened and ground shafts are generally recommended for use with BALL BUSHINGS. The requirement for surface hardness of shafting depends on the load which the bearing must support. Data on this should be obtained from Pages 24 and 25.

If too soft a shaft is used for a given load, the balls will form or "cold work" a race or ball conforming groove along the working length of the shaft. Grooves so formed will increase the looseness of the fit but will not affect the bearing's operation within reasonable depth limits. In applications where looseness can be tolerated and a soft shaft is used, it is possible to periodically rotate the shaft or bearing slightly to obtain a new working surface and eliminate the looseness which has developed. This operation should only be done with *all load removed* from the bearing.

60 Case is available in 1060 Steel, 1060 TUBULAR Steel and in 440C STAINLESS Steel. For engineering specifications see Page 30. For prices refer to Price Sheet inserted inside back cover. Quotations on shafts with special machining will be made promptly upon receipt of a detailed sketch and information concerning the quantity required. If additional information is required contact your local representative whose name is shown on back cover ... or phone or write factory direct.

# SEALS and DUST BOOTS

## Sealing requirements must be determined for each application

No bearing, plain or anti-friction, rotary or linear, can operate satisfactorily if contaminated with dust, dirt, grit or any foreign matter. Seals are not included as an integral part of BALL BUSHINGS because the requirements for them vary greatly with the application. In some installations, no seals or dust boots may be necessary, whereas extremely unsanitary atmospheres demand the utmost in protection.

Other factors to consider in selecting a means of excluding foreign matter are the method of lubrication planned for the BALL BUSHING and the amount of friction that can be tolerated.

## Press Fit

It is often desirable to have a Push Fit of the BALL BUSHING in its housing hole, instead of a Press Fit, to eliminate the possibility of excessively reducing the working bore of the bearing with too tight a press. In this case, a *Press Fit of the seal* can often be used on one or both ends to secure a *Push Fit* BALL BUSHING in its housing hole.

Felt or leather washers can be retained by a Press Fit ring as shown on the right of Fig. 17. These will protect against a reasonable amount of atmospheric dust and cause very little friction. They are very inexpensive but will not hold lubricant over long periods in high speed applications.

Synthetic rubber seals having a plain or spring load lip can be used when more effective dirt exclusion and lubricant retention are required. The spring loaded type is more effective and causes slightly more friction. It is also more expensive. Various installation methods are suggested by Fig. 17 and Fig. 18.

Information on Standard BALL BUSHING Seals can be obtained from Page 31. These have been designed for linear motion and have dimensions matching the BALL BUSHING with which they are to be used.

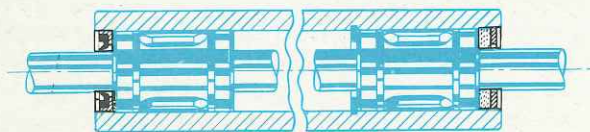


Fig. 17

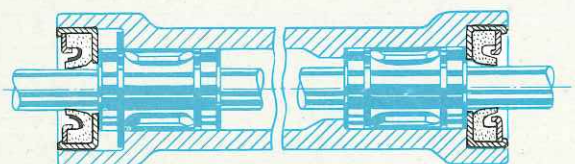


Fig. 18

## Dust Boots

Dust boots of the pleated or bellows type are illustrated in Fig. 19. These afford excellent protection for the bearings and do not seriously affect the linear freedom of the shaft. A molded synthetic rubber type is shown to the left of the Figure, while a sewn cloth or leather boot is suggested on the right. When selecting or designing a dust boot, the length of stroke is important. A simple cloth sock sewn over a light wire coil spring can sometimes be used successfully on relatively long strokes. If linear speeds are appreciable, it may be necessary to vent any type of boot to prevent bursting due to the pumping action.

*Names of manufacturers of bellows type dust boots may be obtained from classified manufacturers directories or from Thomson Industries, Inc.*

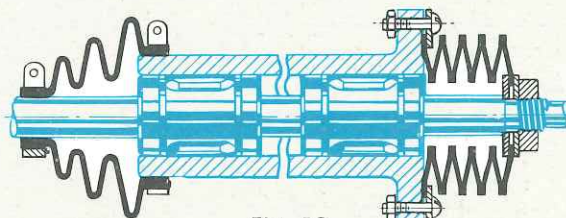
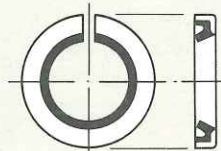


Fig. 19

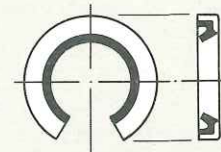
## Seals for Adjustable Diameter Ball Bushings



The longitudinal slots, in the housings and in the BALL BUSHINGS, may be sealed with a narrow strip of felt or other resilient material.

The ends of the BALL BUSHING may be sealed with a synthetic rubber BALL BUSHING Seal which has been slotted to permit diameter adjustments. These are otherwise the same as Series "S" Seals (See Page 31). Identify with prefix ADJ. Thus: ADJ-S-2000 for 2" size Adjustable Seals.

## Seals for Open Type Ball Bushings



The ends of the Open Type BALL BUSHINGS may be sealed with a synthetic rubber BALL BUSHING Seal which has had a section removed to permit it to pass over the shaft's supports. These are otherwise the same as Series "S" Seals (See Page 31). Identify with prefix OPN. Thus: OPN-S-2000 for 2" size Open Seals. Our engineering department will be pleased to make recommendations for any unusual sealing requirements.

## RESILIENT MOUNTS

*Where absolute rigidity is not essential*



Fig. 20 — Ball Bushing with Resilient Mount

Resilient BALL BUSHING Mounts are sometimes used for installations where absolute rigidity is not essential and where a slightly larger housing bore can be accommodated. The self-aligning feature of these mounts offers users important benefits. They guarantee uniform load distribution over the entire length of the load-carrying balls; they compensate for slight errors in housing bores and parallel shaft alignment; they reduce shaft straightness requirement and noise by insulating bearing from metal-to-metal contact with housing; they eliminate the need for close tolerance and smooth finish on housing bores and permit moderate shaft deflection without danger of damage to bearing or shaft.

Basically, the resilient mount consists of a band of resilient material having a cross section of special design which can be easily mounted around the outside of the BALL BUSHING. This provides a permanent, resilient, self-aligning support for the bearings.

Once properly installed, there is no danger of the assembly becoming loose in the housing. BALL BUSHINGS equipped with resilient mounts may be pushed into the housing bore of the recommended diameter and aligned with finger pressure only. Within a few minutes after installation, the resilient material will start to "set" or lock in position and resist further movements beyond the resiliency of the material. After a few hours the Bushing will be held firmly in place and mechanical pressure will be required to remove it. It is important to align the Bushing as accurately as possible after pushing it into the housing bore. Once "set," the resiliency of the material will permit self-aligning within a few degrees.



*For dimensions of standard sets of Resilient Mounts see Page 32. For prices refer to Price Sheet inserted inside back cover.*

## COMBINATION BEARINGS

*For "Linear & Rotary" Motions*

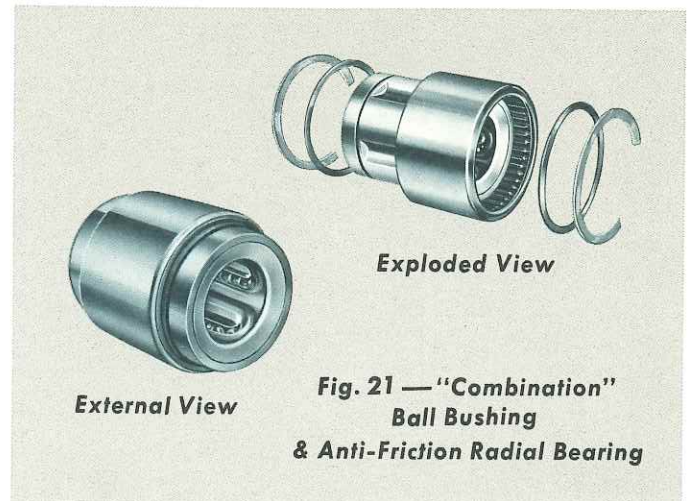


Fig. 21 — "Combination"  
Ball Bushing  
& Anti-Friction Radial Bearing

The design of the BALL BUSHING is such that relative rotation between the Bushing and the shaft will normally cause the balls to rub against the sides of the ball retainers. This rubbing (or skidding) action of the balls will in time produce wear or deformation. The extent of this wear will be governed by the rate of rotation, duration and loading. BALL BUSHINGS are therefore *not* normally recommended for use in applications where a mechanism that both rotates and reciprocates must be supported. The sole exception to this is where the shaft or BALL BUSHING is slowly rotated for positioning under light loads.

The manner in which a combined linear-rotary motion may be handled safely is to use rotary needle, roller or ball bearings in combination with BALL BUSHINGS as indicated in Figure 21. In these applications, radial bearings are mounted on the outside diameter (which is a ground surface) of the BALL BUSHING and centrally positioned by means of spacer rings and retaining rings. O. D. retainer ring grooves near the ends of the BALL BUSHING is standard design. As rotation occurs it takes place between the BALL BUSHING O. D. and the radial bearing I. D. while the BALL BUSHING moves freely in a linear (or reciprocating) direction.

**CAUTION — Applications involving heavy loads combined with high radial speeds, high rates of acceleration or deceleration, or high radial inertial forces, are to be approached with caution. For service of this type it is recommended that tests be conducted before finalizing design.**



*For general recommendations on standard sets of radial bearings, retaining and spacer rings for "combined motion" applications see Table 21 on Page 33. For prices refer to Price Sheet inserted inside back cover. If additional information is required contact your local representative whose name is shown on back cover . . . or phone or write factory direct.*

# COEFFICIENT of FRICTION

**Low friction is an important feature of Ball Bushings.**

The coefficient of friction of BALL BUSHINGS — 0.001 to 0.004 — is extremely low, and is approximately that of *radial* ball bearings. It is far less than the coefficient of friction of sliding surfaces and, more important, is *far more constant*. This applies to the coefficient of rolling or operating friction as well as to the coefficient of static or break-away friction. From a practical standpoint, this low coefficient of friction is minute enough to be disregarded in most applications. A *constant* low coefficient of friction is imperative in many applications where stick-slip action impairs performance.

Extensive testing under controlled conditions has determined coefficients of rolling and static friction for the entire series of BALL BUSHINGS. These values may be used to estimate forces required to overcome frictional resistance in specific applications.

The formula used to determine frictional resistance during operation is:

$$P = L \times f_r, \text{ where } P = \text{Frictional resistance (pounds)}$$

$$L = \text{Applied load (pounds), perpendicular to centerline of shaft}$$

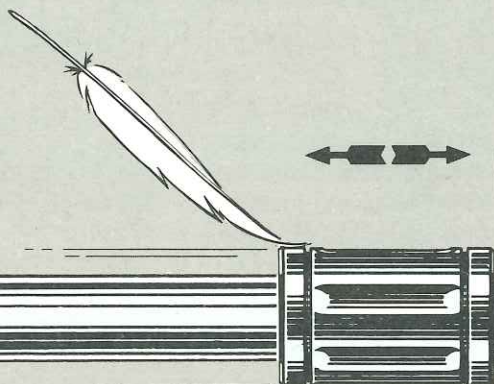
$$f_r = \text{Coefficient of rolling friction}$$

The formula used to determine static frictional resistance is:

$$P = L \times f_o, \text{ where } f_o = \text{Coefficient of static friction}$$

Following is a list of coefficients of rolling friction ( $f_r$ ) of BALL BUSHINGS operating on hardened and ground shafts of recommended diameters. These values are grouped according to the number of ball circuits in each Bushing as friction coefficients are constant among Bushings having 3 and 4 ball circuits but slightly less for Bushings with 5 or 6 ball circuits. To make the table easy to use Bushing sizes in each group are also listed.

The values for the coefficient of static or break-away friction are also listed. These values are not measurably affected by the number of ball circuits in the Bushing or by conditions of lubrication.



## Variables affecting friction of Ball Bushings

**SPEED** — There are no appreciable variations in coefficients of rolling friction at various speeds.

**LUBRICATION** — Dry BALL BUSHINGS have the lowest coefficient of friction due to the complete absence of lubricant surface tension (meniscus drag) effects. Values for grease lubrication range from 100% greater in the smaller sizes to 20%-to-50% greater in the larger sizes. Oil lubrication (medium-heavy, viscosity 64 c.s. @ 100° F.) gives frictional values slightly higher than those for grease lubrication.

**SEAL FRICTION** — Where seals or flexible bellows are used to retain lubricant or to prevent entry of foreign particles, frictional resistance from these elements must also be taken into consideration in calculations made to determine total frictional drag. Where minimum friction is desired, sealing elements with minimum frictional drag are used or sealing elements are eliminated by design. BALL BUSHINGS are not as critical as radial ball bearings with respect to foreign particles as they are pushed aside by the ball action and are not trapped between balls and ball conforming grooves.

## Coefficients of Rolling Friction ( $f_r$ ) of Ball Bushings

$$f_r = \frac{P}{L} \text{ where } P \text{ equals frictional resistance and } L \text{ equals applied load}$$

BUSHING I.D.	NUMBER of BALL CIRCUITS	CONDITION of LUBRICATION	LOAD IN % OF ROLLING LOAD RATING (for 2,000,000 inches of travel life)				
			125%	100%	75%	50%	25%
1/4", 3/8", 1/2"	3 & 4	No Lube	.0011	.0011	.0012	.0016	.0025
		Grease Lube	.0019	.0021	.0024	.0029	.0044
		Oil Lube	.0022	.0023	.0027	.0032	.0045
3/4", 1"	5	No Lube	.0011	.0011	.0012	.0015	.0022
		Grease Lube	.0018	.0019	.0021	.0024	.0033
		Oil Lube	.0020	.0021	.0023	.0027	.0036
1 1/4" thru 4"	6	No Lube	.0011	.0011	.0012	.0014	.0019
		Grease Lube	.0016	.0016	.0017	.0018	.0022
		Oil Lube	.0018	.0018	.0019	.0021	.0027

## Coefficients of Static Friction ( $f_o$ ) of Ball Bushings

LOAD IN % OF ROLLING LOAD RATING				
125%	100%	75%	50%	25%
.0028	.0030	.0033	.0036	.0040

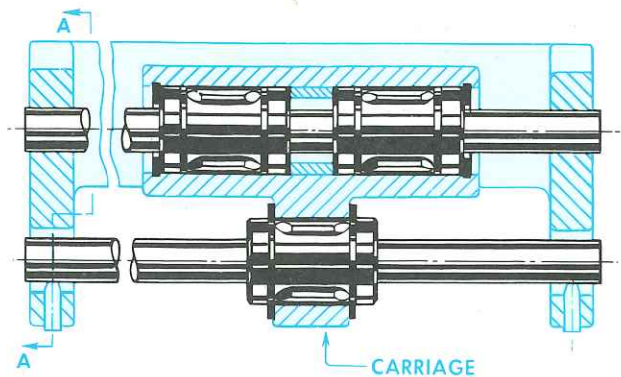
Values are based on use of shafts of recommended diameters, hardened to Rockwell 58-63C.

# MOUNTING ARRANGEMENTS

*If parallel shafts are used in precision applications, accurate alignment is important.*

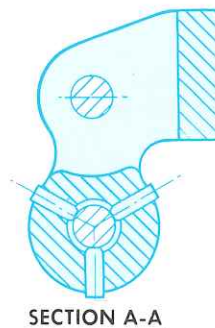
When BALL BUSHINGS are used to mount a carriage for linear travel, it is frequently necessary to prevent the carriage from rotating. Two parallel shafts may be used for this purpose. In precision applications where little or no play can be tolerated and the shafts are fitted closely to the bearings, care must be exercised to assure parallelism of the shafts or roughness and possible damage to the bearings may result. Shaft parallelism can be obtained by accurate location of the shaft mounting holes or by providing an adjustment to permit proper alignment. Resilient mounting of one of the BALL BUSHINGS or a floating arrangement of one of the shafts or BALL BUSHINGS can sometimes be used as an alternative arrangement. *For information on resilient BALL BUSHING mounts see Page 20.* For applications in which both rigidity and extreme precision are required, individual BALL BUSHING mounting blocks are recommended. This permits precise adjustment and alignment of BALL BUSHINGS to shafts. In many non-precision light load applications the shafts can be finished to a diameter sufficiently undersize to allow for a reasonable amount of shaft or bearing misalignment.

Instead of using two parallel shafts, it may be preferable to make use of a linkage or roller guides to prevent rotation of the carriage on a single shaft. The accompanying illustrations suggest a few of the many mounting arrangements possible with BALL BUSHINGS.

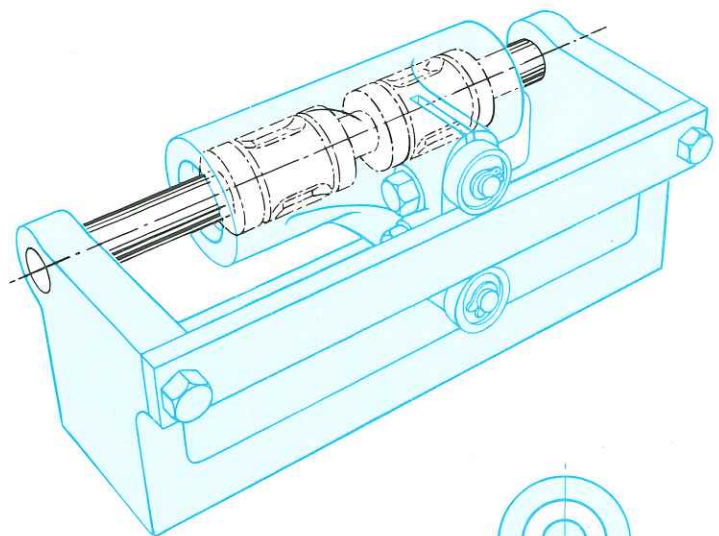


**Fig. 22 — Parallel Shafts  
with Adjustment**

A linear travel carriage mounted on three BALL BUSHINGS, two of which ride on a fixed shaft and the third on an adjustable parallel shaft which is retained at each end by three set screws in an oversize hole. The adjustments can be used to take out play due to diametral clearance between the shaft and bearings as well as for shaft alignment.

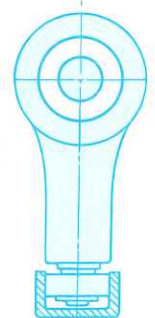


**SECTION A-A**

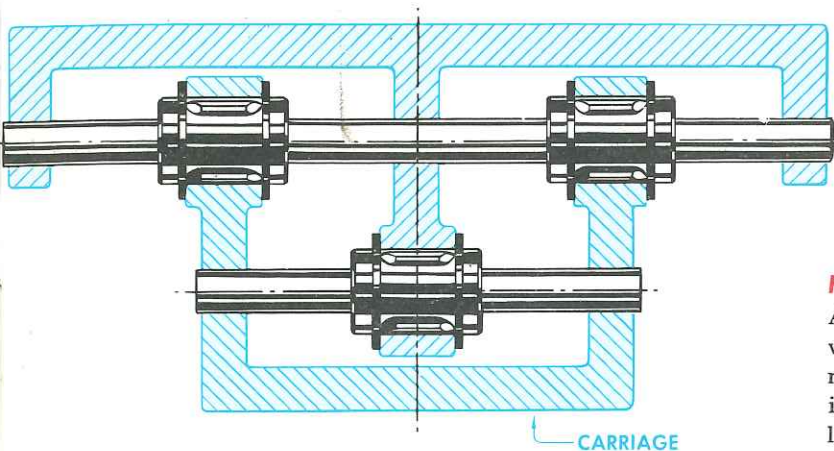


**Fig. 23 — Carriage on Single  
Shaft in Combination with a  
Torque Roller**

A linear travel carriage mounted on two BALL BUSHINGS which ride on a fixed shaft, with provision for double or single rollers riding on a guide rail to prevent rotation of the carriage.

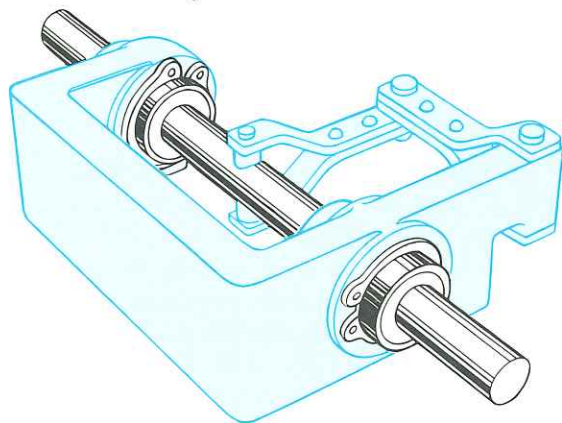


**ALTERNATIVE  
MOUNTING  
USING U-CHANNEL &  
SINGLE ROLLER**



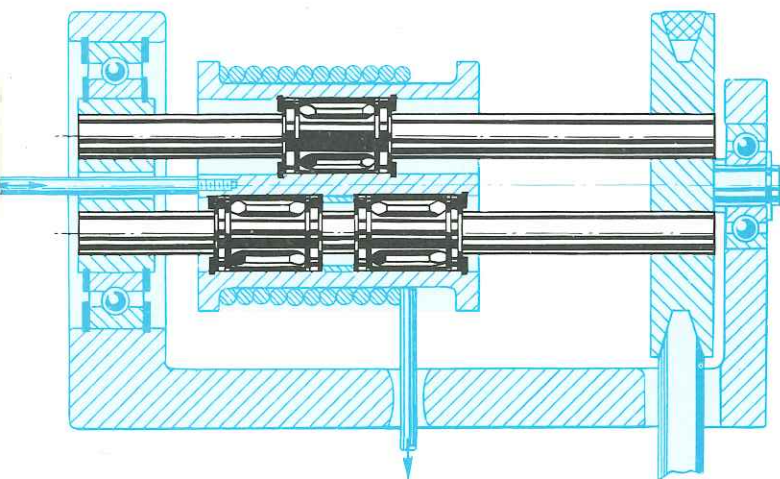
**Fig. 24 —Long and Short Parallel Shafts**

A linear travel carriage mount, featuring two BALL BUSHINGS mounted on the carriage and riding on a long fixed shaft with an intermediate support, and a third BALL BUSHING mounted on the fixed structure and riding on a parallel shaft which is mounted on the carriage.



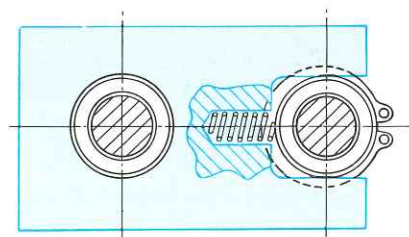
**Fig. 25 —Single Shaft with Linkage Guide**

A shaft mounted on two BALL BUSHINGS with an intermediary linkage to prevent relative rotation between the shaft and the bearing housing during linear travel.



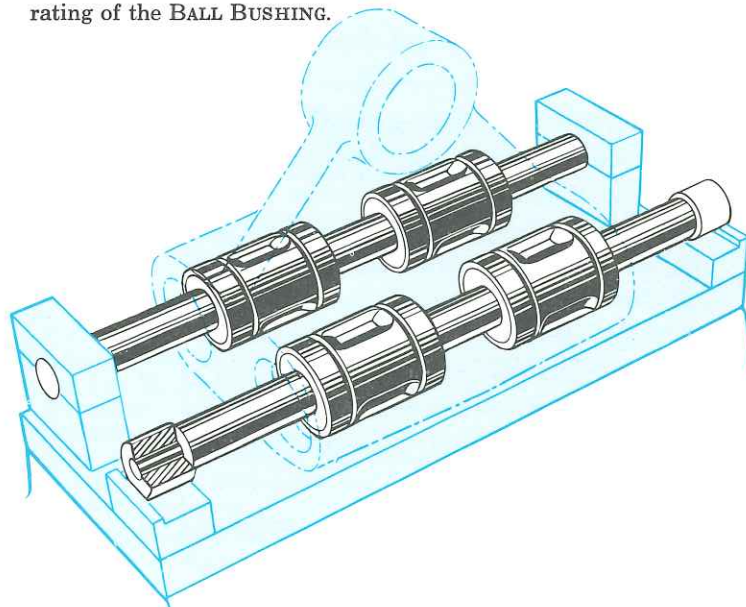
**Fig. 26 —Torque Transmission**

Torque can be transmitted to or from a free rolling linear motion by mounting the reciprocating part on a pair of parallel shafts which are secured in the rotating members.



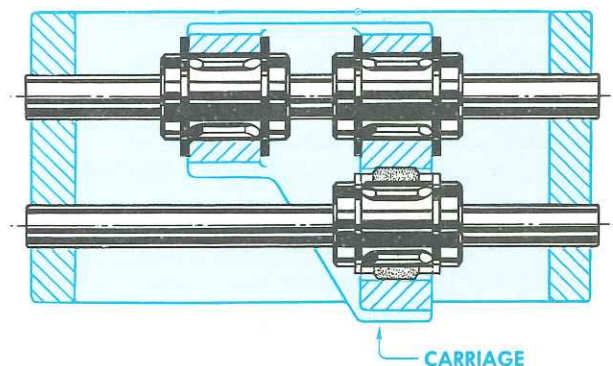
**Fig. 27 —Spring Loaded Ball Bushings**

A floating BALL BUSHING can be spring loaded in numerous ways to take out all shake or play resulting from the recommended diametral clearance between the shaft and the bearing. The spring force should be well in excess of the maximum load on the mechanism, but no more than the rolling load rating of the BALL BUSHING.



**Fig. 28 —Floating Shaft**

In applications where the load is always in one direction, one shaft can be rigidly mounted and the other allowed to float on rollers riding on hardened pads. In this arrangement, the shafts are self-aligning in one plane, but the pads must be dimensioned or shimmed to assure parallelism in the other plane.



**Fig. 29 —Parallel Shafts with a Resilient Mounted Ball Bushing**

A linear travel carriage mounted on three BALL BUSHINGS, two of which are rigidly mounted in the carriage and ride on a fixed shaft, and a third in a standard resilient mount riding on a fixed parallel shaft. See Page 20.

## LUBRICATION

*The choice between oil or light grease depends on the installation.*

Since BALL BUSHINGS operate on the principle of a rolling ball, they require much less lubrication than do sleeve bearings. In some lightly loaded, low speed applications, and in atmospheres contaminated with foreign particles, BALL BUSHINGS have been used without any lubrication whatsoever. For most applications, however, a lubricant is recommended to prevent rusting of the highly polished bearing surfaces and to minimize wear.

A light oil is generally used where the linear speed is high. At very high speeds provision should be made to prevent bearings from running dry for any prolonged length of time.

A medium-heavy oil or a light grease has the advantage of greater surface adhesion which affords longer bearing protection and minimizes sealing problems. The numerous pockets in the bearing's retainers will hold a liberal initial supply of either oil or grease.

If seals are used in the installation, they will minimize the loss of lubricant. Seals of the type shown in Fig. 17 and Fig. 18 can retain an adequate amount of oil or grease within the bearing for long periods of normal operation. In applications where lubrication is more important than dirt exclusion, the seal's effectiveness for retaining lubricant can be increased by reversing the seal so that the lips point inward toward the bearing.

*For dimensions of standard BALL BUSHING Seals see Page 31. For prices refer to Price Sheet inserted inside of back cover.*

*The load capacity of a BALL BUSHING and shaft combination is influenced by the life expectancy, by the hardness of the shaft, and by the circumferential positioning of the load-carrying working tracks in relation to the direction of the applied load.*

Life expectancy is expressed in terms of the total inches of linear movement between the BALL BUSHING and the shaft during its operating life and is known as its *Travel Life*. The shaft hardness is expressed in terms of the Rockwell "C" required for no grooving of the shaft. (See Page 18 for information on 60 Case hardened and ground BALL BUSHING Shafts.)

The *Rolling Load Ratings* given in Tables 2 thru 6 on Pages 27 and 28 are based on a shaft hardness of Rockwell 60C and a Travel Life of 2,000,000 inches. To find the Allowable Load Capacity for other conditions of Travel Life or shaft hardness, the Rolling Load Ratings must be multiplied by the appropriate load correction factors  $K_L$  and  $K_H$  obtained from Chart 1 and Chart 2 respectively. To solve for other items refer to Table 1.

The *Static Load Ratings* given in Tables 2 thru 6 are based on a shaft hardness of Rockwell 60C and must be corrected by factor  $K_H$  when a softer shaft is used. They are given to indicate allowable non-Brinell loads and are to be used only in special cases where the expected Travel Life is relatively low.

BALL BUSHING load capacity ratings are based on the amount of travel that may be expected before wear occurs. If provisions can be made for rotation of the Bushing or shaft to bring new bearing surface into play, a longer life will result. *The Bushing or shaft should be rotated with all load removed!*

If soft shafts are used under moderate or high load conditions, the balls will form a groove along the working length. As a result, fit will be loose, but operation of the bearing will not be affected within reasonable depth limits.

For moderate and high load applications where maximum life is desired, shafts having hardness of Rockwell 58-63C are recommended. (See Pages 18 and 30 for more information.)

# ... and BALL BUSHING LIFE

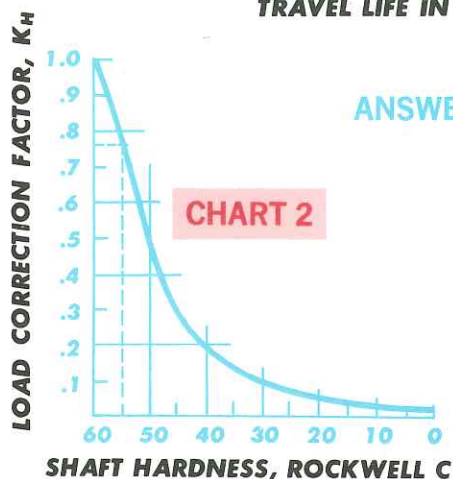
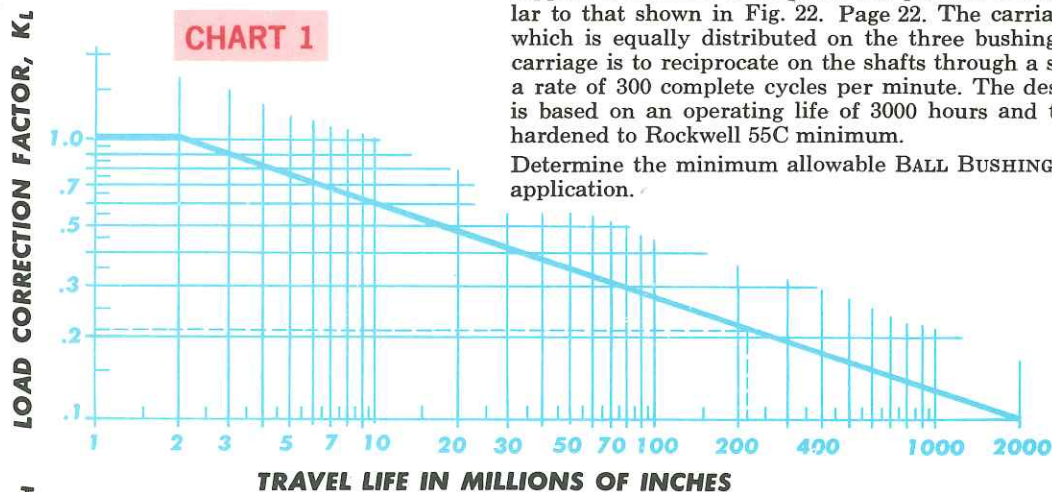
TABLE 1

IF YOU WISH TO DETERMINE:	AND YOU KNOW:	THEN SOLVE FOR:
1. Allowable load capacity	a. BALL BUSHING size b. Travel life required c. Shaft hardness	Allowable load capacity = Rolling Load Rating $\times K_L \times K_H$
2. Travel life expectancy	a. BALL BUSHING size b. Load capacity req'd c. Shaft hardness	$K_L = \frac{\text{Load Capacity req'd}}{\text{Rolling Load Rating} \times K_H}$ and read travel life from Chart 1
3. Minimum allowable bushing size	a. Load capacity req'd b. Travel life req'd c. Shaft hardness	Rolling Load Capacity = $\frac{\text{Load Capacity Req'd}}{K_L \times K_H}$ and choose bushings with the next highest rating from Tables 2 thru 6
4. Minimum allowable shaft hardness	a. BALL BUSHING size b. Load capacity req'd c. Travel life req'd	$K_H = \frac{\text{Load Capacity Req'd}}{\text{Rolling Load Rating} \times K_L}$ and read shaft hardness from Chart 2

## EXAMPLE:

In the design of a machine, three BALL BUSHINGS are to be used to support a movable carriage on two parallel shafts in a manner similar to that shown in Fig. 22, Page 22. The carriage weight is 90 lbs. which is equally distributed on the three bushings. In operation the carriage is to reciprocate on the shafts through a stroke of 2 inches at a rate of 300 complete cycles per minute. The design of the machine is based on an operating life of 3000 hours and the shafts are to be hardened to Rockwell 55C minimum.

Determine the minimum allowable BALL BUSHINGS size for the above application.



**ANSWER:** From the data given above it is known that:

$$\text{Load Capacity required per bushing} = \frac{90}{3} = 30 \text{ pounds}$$

Travel life =  $(2" \times 2) \times 300 \text{ CPM} \times 60 \text{ min.} \times 3000 \text{ hrs.} = 216,000,000$  inches • Shaft hardness = Rockwell 55C • Referring to TABLE 1 it is noted that, in determining minimum allowable bushing size, the following formula is used:

$$\text{Rolling Load Capacity} = \frac{\text{Load Capacity Req'd}}{K_L \times K_H} = \frac{30}{.215 \times .76} = 184 \text{ pounds}$$

Referring to the Rolling Load Ratings in TABLE 2 on Page 27 it is found that Bushing No. A-162536 for a 1" diameter shaft is the minimum size which can be used in the above application.

# POSITIONING of BALL BUSHING INCREASES CAPACITY

*The circumferential positioning of the Ball Bushing's load-carrying tracks under a single-directional load may be utilized to obtain an increase in load capacity.*

The load ratings in Tables 2 thru 6 are based on the worst of loading conditions. They are, therefore, conservative. When the load does not vary in direction of application, the load ratings can be increased. This requires that each Bushing be installed and maintained in a definite angular position (See Fig. 30). The load correction factors shown can then be used.

**For EXAMPLE:** Three BALL BUSHINGS are to be used to support a carriage on two parallel shafts. Carriage weight of 75 lbs. is equally distributed on the Bushings. The carriage reciprocates on the shafts through a stroke of 2 inches at 300 cycles per minute. Design of the machine is based on an operating life of 3000 hours; shafts are hardened to Rockwell 55C minimum.

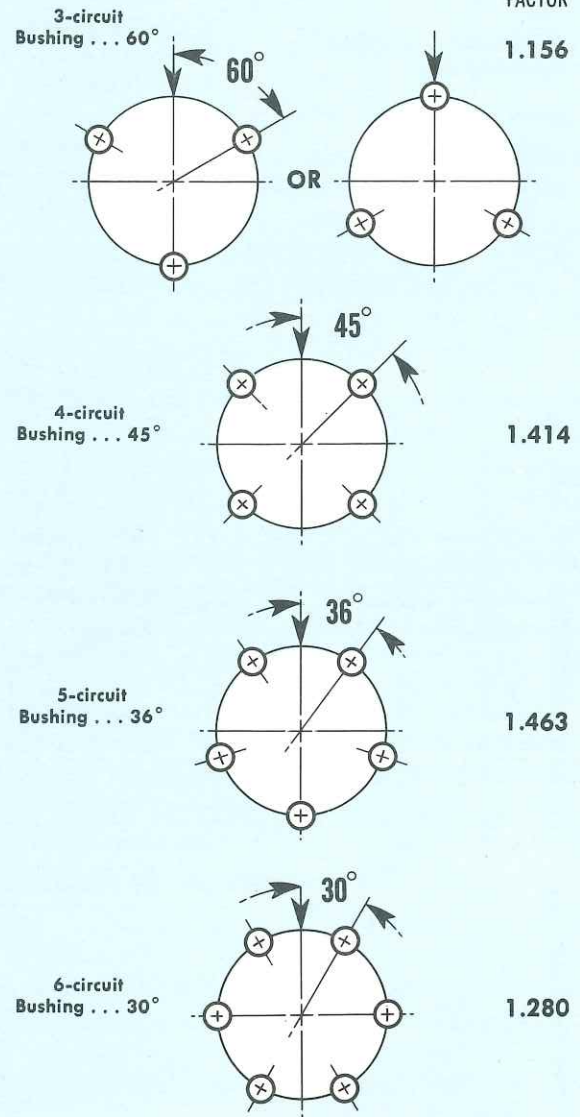
Load capacity required per Bushing is  $75/3 = 25$  lbs. Required travel life is  $(2 \times 2) (300) (60) (3000) = 216$  million inches. Dividing by the load correction factors from Chart 1 and Chart 2 gives  $25 / (0.215 \times 0.76) = 155$  lbs., the required rolling load rating.

This application would require a Bushing for a 1"-dia. shaft. (Tables 2 thru 6). If, however, the load is constant in direction, and each Bushing can be installed so that the working ball tracks are positioned to provide maximum load capacity (Fig. 30), a smaller bearing might do. Both the 1-inch and  $\frac{3}{4}$ -inch bore Bushings contain five ball circuits. Using the orientation load correction factor of 1.463 (Fig. 30)  $\times$  the rated load capacity of 109 lbs. ( $\frac{3}{4}$ " Bushing), the corrected load rating is found to be 160 lbs. Under these conditions, the  $\frac{3}{4}$ "-bore Bushing would be satisfactory.

Positioning working ball tracks as shown below increases load ratings over those listed in Tables 2 thru 6 by ratios shown below at right:

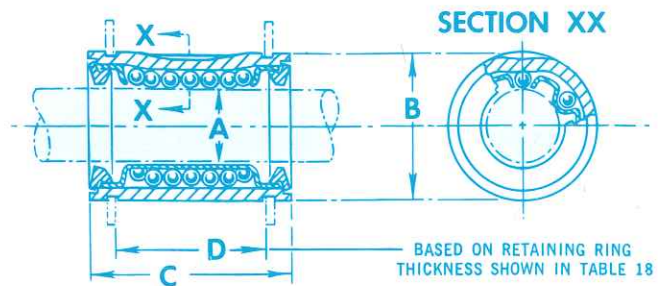
Multiply load rating  
by  
Load Correction Factor

ORIENTATION  
LOAD  
CORRECTION  
FACTOR



**Fig. 30**  
**POSITIONING LOAD-CARRYING**  
**BALL TRACKS**

# BALL BUSHING ENGINEERING SPECIFICATIONS



**Table #2 — PRECISION Series A — Dimensions & Load Ratings**

Series A Ball Bushing Number	Working Bore		Outside Diameter		Length		Dist. Between Retaining Rings		Maximum Permis- sible Shaft Dia. ***	Recommended Housing Bore				Ball Dia- meter	Number of Ball Circuits	Bushing Weight	Rated Load*			Series A Ball Bushing Number	
	A	Tol. +.0000 to	B	Tol. +.0000 to	C	Tol. +.0000 to	D			Norm. Fit	Tol. -.0000 to	Press Fit	Tol. -.0000 to				Inches	Pounds	Pounds		Pounds
Inches		Inches		Inches		Inches	Tol.	Inches	Inches		Inches										
A-4812	.2500	-.0005	.5000	-.0004	.750	-.015	.437	±.010	.2490	.5000	+.0005	.4990	+.0005	1/16"	3	.02	22	13	A-4812		
A-61014	.3750	-.0005	.6250	-.0004	.875	-.015	.562	±.010	.3740	.6250	+.0005	.6240	+.0005	1/16"	4	.06	38	21	A-61014		
A-81420	.5000	-.0005	.8750	-.0004	1.250	-.015	.875	±.010	.4990	.8750	+.0005	.8740	+.0005	3/32"	4	.08	72	46	A-81420		
A-122026	.7500	-.0005	1.2500	-.0004	1.625	-.015	1.062	±.010	.7490	1.2500	+.0005	1.2490	+.0005	1/8"	5	.21	162	109	A-122026		
A-162536	1.0000	-.0005	1.5625	-.0004	2.250	-.015	1.625	±.010	.9990	1.5625	+.0005	1.5615	+.0005	5/32"	5	.38	262	202	A-162536		
A-203242	1.2500	-.0006	2.0000	-.0005	2.625	-.020	1.875	±.015	1.2490	2.0000	+.0010	1.9983	+.0010	3/16"	6	1.10	465	344	A-203242		
A-243848	1.5000	-.0006	2.3750	-.0005	3.000	-.020	2.250	±.015	1.4989	2.3750	+.0010	2.3733	+.0010	1/2"	6	1.43	695	535	A-243848		
A-324864	2.0000	-.0008	3.0000	-.0006	4.000	-.020	3.000	±.015	1.9987	3.0000	+.0010	2.9982	+.0010	1/4"	6	2.75	1100	850	A-324864		
A-406080	2.5000	-.0010	3.7500	-.0008	5.000	-.025	3.750	±.015	2.4985	3.7500	+.0010	Not Normally Recommended	5/16"	6	5.50	1710	1380	A-406080			
A-487296	3.0000	-.0012	4.5000	-.0010	6.000	-.030	4.500	±.015	2.9983	4.5000	+.0010		3/8"	6	9.50	2460	2000	A-487296			
A-6496128	4.0000	-.0020	6.0000	-.0012	8.000	-.040	6.000	±.020	3.9976	6.0000	+.0010		1/2"	6	20.20	4400	3800	A-6496128			

\*Based on a shaft hardness of Rockwell 60C.

\*\*\*For normal fit slightly larger shafts may be used with caution. (See Page 18)

\*\*Based on a travel life of 2 million inches. (See Page 25)

**STAINLESS STEEL:** Series A, XA, ADJ and OPN BALL BUSHINGS are available made entirely of Stainless Steel. They are identified by the suffix SS following the part number (Example — XA-81420-SS). Series A and XA are stocked only in sizes up to and including 1". Series ADJ and OPN are stocked in 1/2", 3/4" and 1". For larger sizes see note on Page 29.

**Table #3 — SUPER PRECISION Series XA — Dimensions & Load Ratings**

Series XA Ball Bushing Number	Working Bore		Concen- tricity	Outside Diameter		Length		Dist. Between Retaining Rings		Maximum Permis- sible Shaft Dia. ***	Recommended Housing Bore			Ball Diameter	Number of Ball Circuits	Bushing Weight	Rated	Load*	Series XA Ball Bushing Number						
	A	Tol. +.0000 to		B	Tol. +.0000 to	C	Tol. +.0000 to	D			Norm. Fit†	Tol. -.0000 to	Press Fit				Static	Rolling **							
								Inches	Tol. +.0000 to											Inches	Tol. +.0000 to	Inches	Tol.	Inches	Inches
XA-4812	.2500	-.0003	.0005	.5000	-.0004	.750	-.015	.437	±.010	.2495	.5000	+.0005	NOT NORMALLY RECOMMENDED	1/16"	3	.02	22	13	XA-4812						
XA-61014	.3750	-.0003	.0005	.6250	-.0004	.875	-.015	.562	±.010	.3745	.6250	+.0005		1/16"	4	.06	38	21	XA-61014						
XA-81420	.5000	-.0003	.0005	.8750	-.0004	1.250	-.015	.875	±.010	.4995	.8750	+.0005		3/32"	4	.08	72	46	XA-81420						
XA-122026	.7500	-.0003	.0005	1.2500	-.0004	1.625	-.015	1.062	±.010	.7495	1.2500	+.0005		1/8"	5	.21	162	109	XA-122026						
XA-162536	1.0000	-.0003	.0005	1.5625	-.0004	2.250	-.015	1.625	±.010	.9995	1.5625	+.0005		5/32"	5	.38	262	202	XA-162536						
XA-203242	1.2500	-.0004	.0010	2.0000	-.0005	2.625	-.020	1.875	±.015	1.2495	2.0000	+.0010		3/16"	6	1.10	465	344	XA-203242						
XA-243848	1.5000	-.0004	.0010	2.3750	-.0005	3.000	-.020	2.250	±.015	1.4994	2.3750	+.0010		1/2"	6	1.43	695	535	XA-243848						
XA-324864	2.0000	-.0004	.0010	3.0000	-.0006	4.000	-.020	3.000	±.015	1.9994	3.0000	+.0010		1/4"	6	2.75	1100	850	XA-324864						
XA-406080	2.5000	-.0005	.0015	3.7500	-.0008	5.000	-.025	3.750	±.015	2.4993	3.7500	+.0010		5/16"	6	5.50	1710	1380	XA-406080						
XA-487296	3.0000	-.0006	.0015	4.5000	-.0010	6.000	-.030	4.500	±.015	2.9992	4.5000	+.0010		3/8"	6	9.50	2460	2000	XA-487296						
XA-6496128	4.0000	-.0010	.0020	6.0000	-.0012	8.000	-.040	6.000	±.020	3.9988	6.0000	+.0010	1/2"	6	20.20	4400	3800	XA-6496128							

\*Based on a shaft hardness of Rockwell 60C.

\*\*Based on a travel life of 2 million inches. (See Page 25)

†For extreme precision, tolerance may be reduced.

\*\*\*Slightly larger shafts may be used with caution. (See Page 18)

**Table #4 — COMMERCIAL GRADE Series B — Dimensions & Load Ratings**

Sold Only in lots  
of 250 or more.

Series B Ball Bushing Number	Working Bore		Outside Diameter*		Length		Dist. Between Retaining Rings		Maximum Permissible Shaft Diameter		Recommended Housing Bore				Ball Dia- meter	Number of Ball Circuits	Bushing Weight	Rated Load**			Series B Ball Bushing Number		
	A	Tol. -.0000 to	B	Tol. +.0000 to	C	Tol. +.0000 to	D		Norm. Fit	Press Fit	Norm. Fit	Tol. -.0000 to	Press Fit†	Tol. -.0000 to				Inches		Pounds		Pounds	Pounds
Inches		Inches		Inches		Inches	Tol.	Inches	Inches	Inches		Inches		Inches									
B-4812	.2500	+.0020	.5000	-.0015	.750	-.020	.437	±.010	.2495	.2495	.5000	+.0010	.4980	+.0005	1/16"	3	.02	19	11	B-4812			
B-61014	.3750	+.0020	.6250	-.0015	.875	-.020	.562	±.010	.3745	.3740	.6250	+.0010	.6230	+.0005	1/16"	4	.06	33	18	B-61014			
B-81420	.5000	+.0020	.8750	-.0015	1.250	-.020	.875	±.010	.4995	.4990	.8750	+.0010	.8730	+.0005	3/32"	4	.08	61	39	B-81420			
B-122026	.7500	+.0020	1.2500	-.0020	1.625	-.025	1.062	±.015	.7495	.7490	1.2500	+.0010	1.2475	+.0005	1/8"	5	.21	138	93	B-122026			
B-162536	1.0000	+.0020	1.5625	-.0020	2.250	-.025	1.625	±.015	.9995	.9990	1.5625	+.0010	1.5600	+.0005	5/32"	5	.37	222	172	B-162536			
B-203242	1.2500	+.0020	2.0000	-.0020	2.625	-.030	1.875	±.015	1.2495	1.2490	2.0000	+.0010	1.9970	+.0010	3/16"	6	1.10	400	292	B-203242			
B-243848	1.5000	+.0020	2.3750	-.0020	3.000	.030	2.250	±.015	1.4994	1.4989	2.3750	+.0010	2.3720	+.0010	7/32"	6	1.40	590	455	B-243848			

\*Slight out-of-roundness may result from the heat treatment of Series B bearings, making it difficult to measure the true O.D. The bearing will return substantially to its original roundness when inserted into the recommended housing bore for either normal or press fit.

\*\*Based on a shaft hardness of Rockwell 60C.

\*\*\*Based on a travel life of 2 million inches. (See Page 25)

†Do not press fit in soft metal housings. Use normal fit to avoid shearing.

# BALL BUSHING ENGINEERING SPECIFICATIONS

**Table #5 — ADJUSTABLE DIAMETER Series ADJ — Dimensions & Load Ratings**

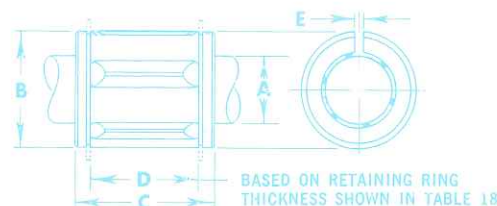
Series ADJ Ball Bushing Number	Ball Bushing Bore Dia. Before Adjustment*		Housing Bore Dia. Before Adjustment**		Length		Dist. Between Retaining Rings		Min. Slot Width	Max. Shaft Dia- meter	Ball Dia- meter	Number of Ball Circuits	Bushings Weight  Pounds	Rated Load†		Series ADJ Ball Bushing Number
	A		B		C		D		E					Static	Rolling ‡	
	Inches	Tol.	Inches	Tol. -.0000 to	Inches	Tol. +.000 to	Inches	Tol.	Inches	Inches	Inches			Pounds	Pounds	
ADJ-81420	.5000	±.0005	.8750	+.0010	1.250	-.015	.875	±.010	1/16"	.4995	3/32"	4	.08	66	42	ADJ-81420
ADJ-122026	.7500	±.0005	1.2500	+.0010	1.625	-.015	1.062	±.010	3/32"	.7495	1/8"	5	.21	162	109	ADJ-122026
ADJ-162536	1.0000	±.0005	1.5625	+.0010	2.250	-.015	1.625	±.015	1/2"	.9995	3/16"	5	.38	262	202	ADJ-162536
ADJ-203242	1.2500	±.0006	2.0000	+.0010	2.625	-.020	1.875	±.015	3/16"	1.2495	3/8"	6	1.10	465	344	ADJ-203242
ADJ-243848	1.5000	±.0006	2.3750	+.0010	3.000	-.020	2.250	±.015	1/8"	1.4994	7/32"	6	1.43	695	535	ADJ-243848
ADJ-324864	2.0000	±.0008	3.0000	+.0010	4.000	-.020	3.000	±.015	1/8"	1.9994	1/4"	6	2.75	1100	850	ADJ-324864
ADJ-406080	2.5000	±.0010	3.7500	+.0015	5.000	-.025	3.750	±.015	1/8"	2.4993	5/16"	6	5.50	1710	1380	ADJ-406080
ADJ-487296	3.0000	±.0012	4.5000	+.0015	6.000	-.030	4.500	±.015	1/8"	2.9992	3/8"	6	9.50	2460	2000	ADJ-487296
ADJ-6496128	4.0000	±.0020	6.0000	+.0020	8.000	-.040	6.000	±.020	1/8"	3.9988	1/2"	6	20.20	4400	3800	ADJ-6496128

\*When installed in nominal housing bore (Column B) before adjustment.

\*\*In processing split housings, the bore is normally made as close to the minimum housing bore as possible with tolerance taken plus. This prevents an excessive initial close-in of the Bushing and allows for controlled take-up of the housing to produce the desired operating fits.

†Based on a shaft hardness of Rockwell 60C.

‡Based on a travel life of 2 million inches. (See Page 25)



**Table #6 — OPEN TYPE Series OPN — Dimensions & Load Ratings**

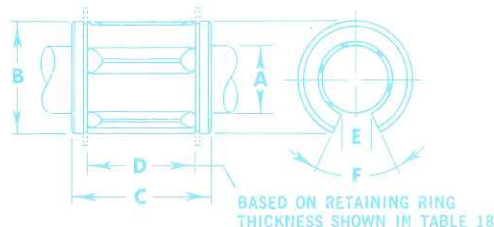
Series OPN Ball Bushing Number	Ball Bushing Bore Dia. Before Adjustment*		Housing Bore Dia. Before Adjustment**		Length		Dist. Between Retaining Rings		Minimum Slot (One Track Removed)		Maximum Shaft Diameter	Ball Dia- meter	Number of Ball Circuits	Bushings Weight  Pounds	Rated Load†		Series OPN Ball Bushing Number
	A		B		C		D		E	F					Static	Rolling ‡	
	Inches	Tol.	Inches	Tol. -.0000 to	Inches	Tol. +.000 to	Inches	Tol.	Width	Angle	Inches	Inches			Pounds	Pounds	
OPN-81420	.5000	±.0005	.8750	+.0010	1.250	-.015	.875	±.010	1/4"	50°	.4995	3/32"	3	.07	66	42	OPN-81420
OPN-122026	.7500	±.0005	1.2500	+.0010	1.625	-.015	1.062	±.010	3/16"	60°	.7495	1/8"	4	.17	162	109	OPN-122026
OPN-162536	1.0000	±.0005	1.5625	+.0010	2.250	-.015	1.625	±.015	1/8"	60°	.9995	3/16"	4	.32	262	202	OPN-162536
OPN-203242	1.2500	±.0006	2.0000	+.0010	2.625	-.020	1.875	±.015	5/16"	50°	1.2495	3/8"	5	.90	465	344	OPN-203242
OPN-243848	1.5000	±.0006	2.3750	+.0010	3.000	-.020	2.250	±.015	3/4"	50°	1.4994	7/32"	5	1.12	695	535	OPN-243848
OPN-324864	2.0000	±.0008	3.0000	+.0010	4.000	-.020	3.000	±.015	1"	50°	1.9994	1/4"	5	2.16	1100	850	OPN-324864
OPN-406080	2.5000	±.0010	3.7500	+.0015	5.000	-.025	3.750	±.015	1 1/4"	50°	2.4993	5/16"	5	4.24	1710	1380	OPN-406080
OPN-487296	3.0000	±.0012	4.5000	+.0015	6.000	-.030	4.500	±.015	1 1/2"	50°	2.9992	3/8"	5	7.33	2460	2000	OPN-487296
OPN-6496128	4.0000	±.0020	6.0000	+.0020	8.000	-.040	6.000	±.020	2"	50°	3.9988	1/2"	5	17.25	4400	3800	OPN-6496128

\*When installed in nominal housing bore (Column B) before adjustment.

\*\*In processing split housings, the bore is normally made as close to the minimum housing bore as possible with tolerance taken plus. This prevents an excessive initial close-in of the Bushing and allows for controlled take-up of the housing to produce the desired operating fits.

†Based on a shaft hardness of Rockwell 60C. Load rating is reduced up to 50% when load is applied on 'open' half of bearing.

‡Based on a travel life of 2 million inches. (See Page 25)



**MATERIALS** Following is a tabulation of the AISI identification of materials used for the components of the various types of BALL BUSHINGS.

Type	Outer Sleeve	Balls	Ball Retainers	End Rings
Series A, XA, ADJ, OPN, DS	52100	Chrome steel	C1020	B1113
Series A, XA, ADJ and OPN Stainless (SS)	440	440	Type 18-8	Type 18-8
Series B	C1020	C1010	C1020	B1113
Series INST-SS	440	440	Brass	None

## LARGER and IN-BETWEEN SIZES

For applications where standard size BALL BUSHINGS cannot be used, small quantities of special size BALL BUSHINGS manufactured on a tool room basis at relatively high cost can be supplied.

## BALL BUSHINGS with NYLON BALLS

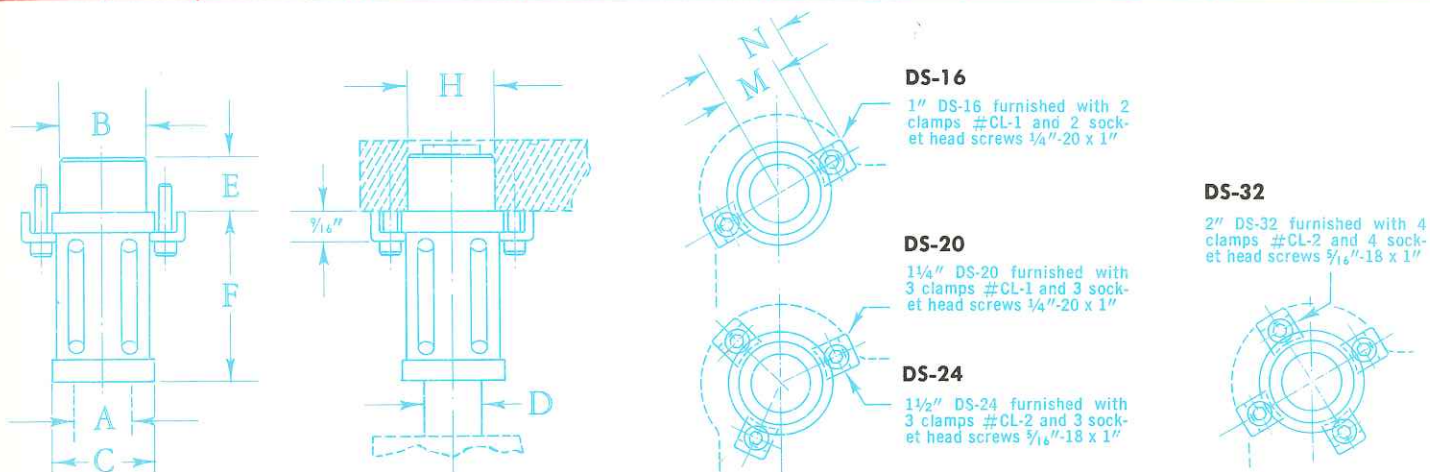
For applications where extremely quiet operation is required, BALL BUSHINGS fitted with nylon balls can be supplied in sizes 1/2" and larger. For estimating purposes load ratings should be considered about 10% of those listed for Bushings with steel balls. Prices and other information on request.

# BALL BUSHING ENGINEERING SPECIFICATIONS

LARGER SIZE ALL-STAINLESS STEEL BALL BUSHINGS (above 1") are available on an individual tool room hand made basis. For limited protection against atmospheric corrosion large sizes can also be supplied with Stainless Steel balls and other components having black oxide surface protection.

**Table #7 — INTERCHANGEABLE Die-Set Ball Bushings Series DS — Dimensions**

Series DS Ball Bushing Number	Bushing Working Bore <b>A</b>		Bushing Pilot Dia. <b>B</b>	O.D. <b>C</b>	Recom'd. Guide Post Dia. <b>D</b>	Bushing Pilot Length <b>E</b>	<b>F</b>	Recom'd. Mounting Hole Dia. <b>H</b>	<b>M</b>	<b>N</b>	Series DS Ball Bushing Number
	Inches	Tol. $+.0000$ to									
DS-16	1.0000	$-.0003$ "	1.5003/1.5007"	$1\frac{7}{32}$ "	1.0000/1.0003"	$1\frac{1}{16}$ "	$3\frac{1}{16}$ "	1.5000/1.5005"	$1\frac{1}{16}$ "	$1\frac{1}{32}$ "	DS-16
DS-20	1.2500	$-.0003$ "	1.7503/1.7507"	$2\frac{1}{16}$ "	1.2500/1.2503"	$1\frac{1}{16}$ "	$3\frac{3}{4}$ "	1.7500/1.7505"	$1\frac{1}{4}$ "	$1\frac{3}{4}$ "	DS-20
DS-24	1.5000	$-.0003$ "	2.0003/2.0007"	$2\frac{3}{32}$ "	1.5000/1.5003"	$1\frac{7}{16}$ "	$4\frac{1}{4}$ "	2.0000/2.0005"	$1\frac{1}{8}$ "	2"	DS-24
DS-32	2.0000	$-.0003$ "	2.5003/2.5007"	$3\frac{1}{32}$ "	2.0000/2.0003"	$1\frac{1}{16}$ "	$4\frac{7}{8}$ "	2.5000/2.5005"	$1\frac{1}{16}$ "	$2\frac{3}{8}$ "	DS-32



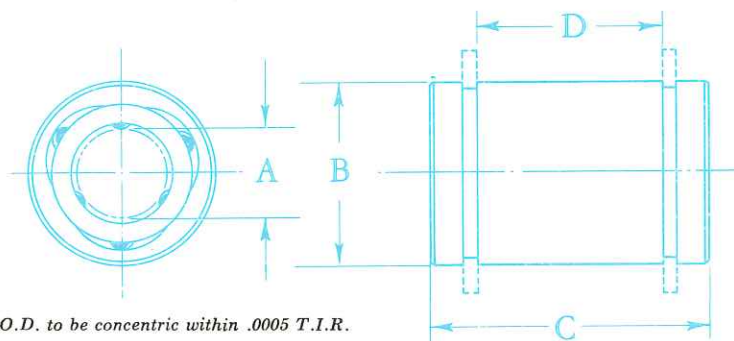
**Table #8 — "Series INST" INSTRUMENT BALL BUSHINGS — Dimensions & Load Ratings**

Series INST Ball Bushing Number	Working Bore		Outside Diameter		Length		Dist. Between Retaining Rings  D		Maximum* Inter-changeable Shaft Dia.	Recommended Housing Bore			Ball Dia.	Number of Ball Circuits	Bushing Weight	Rated Load**		Series INST Ball Bushing Number
	A	Tol. +.0000 to	B	Tol. +.0000 to	C	Tol. +.0000 to				Norm. Fit	Tol. +.0005 to	Press Fit				Static	*** Rolling	
	Inches		Inches		Inches		Inches	Tol.	Inches	Inches		Inch Tol.	Inches		Pounds	Pounds	Pounds	
Inst-258-SS	.1250	-.0003	.3125	-.0004	.500	-.015	.312 ±.010	.1246	.3125	-.0001	None	¾"	3	.01	8	5	Inst-258-SS	
Inst-369-SS	.1875	-.0003	.3750	-.0004	.562	-.015	.375 ±.010	.1871	.3750	-.0001	None	¾"	3	.02	11	6.5	Inst-369-SS	
Inst-4812-SS	.2500	-.0003	.5000	-.0004	.750	-.015	.437 ±.010	.2496	.5000	-.0001	None	⅙"	3	.025	22	13	Inst-4812-SS	

\*Closer fits can be obtained by selective assembly. (See Page 17)

\*\*Based on a shaft hardness of Rockwell 60C.

\*\*\*Based on a travel life of 2 million inches.



# BALL BUSHING *SHAFTS* — Engineering Specifications

## 60 Case HARDENED & GROUND Ball Bushing *SHAFTS*

The shaft on which the BALL BUSHING operates acts as the inner bearing race. To assure a long service life for all but lightly loaded applications, it should be hardened to Rockwell 58-63C to an adequate depth. To provide smooth operation and high precision, it must be smooth, round and unusually straight. 60 Case hardened and ground shafts are of highest quality to meet these requirements . . . are manufactured specifically for BALL BUSHING applications on equipment specially developed by THOMSON INDUSTRIES, INC.

**60 Case *SHAFT SPECIFICATIONS*** — 60 Case material is solid AISI C-1060 Steel hardened to Rockwell 58-63C and centerless ground. Solid *Stainless Steel* is 440C and hardened to 50-55C. Ends are chamfered  $\frac{1}{16}$ " x 45° but not precision finished unless otherwise specified. 60 Case shafts are unusually

straight and within .001/.002" per foot depending on size. Straighter shafts can be supplied at slight extra cost. Surface finish is from 12 to 24 micro inches rms. The length tolerance is  $\pm\frac{1}{32}$ ". ( $\pm\frac{1}{16}$ " for shafts 2" dia. and over). Closer length tolerance can be maintained at extra cost.

**SPECIAL MACHINING** — Complete facilities are available for special machine work. When special machine work is required, send a sketch or print with your request for quotation.

**STOCKED FOR IMMEDIATE DELIVERY** — 60 Case hardened and ground shafts are carried in a factory stock for immediate shipment from Lancaster, Pa., cut to the required length, with or without special machining. Write for our complete 60 Case Catalog.

**Table #9 — SOLID 60 Case Hardened & Ground *SHAFTS* — Material 1060 STEEL — Dimensions**

(Also available in other diameters for other uses)



Nominal Dia.	CLASSES OF TOLERANCE Please specify tolerance "Class" on order.						Minimum Depth of Hardness	Weight Per Inch of Length (lbs.)
	Class "L" Shaft Dia. For use with Series XA, ADJ, OPN and Normal Fit Series B	Max.* Length (Feet)	Class "S" Shaft Dia. For use with Series A and Press Fit Series B Ball Bushings	Max.* Length (Feet)	Class "D" Shaft Dia. for use with Series DS Ball Bushings	Max.* Length (Feet)		
$\frac{1}{4}$ "	.2495/.2490"	8'	.2490/.2485"	8'	—	—	.040"	.014
$\frac{3}{8}$ "	.3745/.3740"	12'	.3740/.3735"	12'	—	—	.040"	.031
$\frac{1}{2}$ "	.4995/.4990"	12'	.4990/.4985"	12'	—	—	.060"	.055
$\frac{3}{4}$ "	.7495/.7490"	12'	.7490/.7485"	12'	—	—	.060"	.125
1"	.9995/.9990"	16'	.9990/.9985"	12'	—	—	.080"	.222
1"	—	—	—	—	1.0000/1.0003"	12'	.080"	.222
1 $\frac{1}{4}$ "	1.2495/1.2490"	16'	1.2490/1.2485"	12'	—	—	.080"	.348
1 $\frac{1}{4}$ "	—	—	—	—	1.2500/1.2503"	12'	.080"	.348
1 $\frac{1}{2}$ "	1.4994/1.4989"	16'	1.4989/1.4984"	12'	—	—	.080"	.500
1 $\frac{1}{2}$ "	—	—	—	—	1.5000/1.5003"	12'	.080"	.500
2"	1.9994/1.9987"	16'	1.9987/1.9980"	12'	—	—	.100"	.890
2"	—	—	—	—	2.0000/2.0003"	6'	.100"	.890
2 $\frac{1}{2}$ "	2.4993/2.4985"	16'	2.4985/2.4977"	12'	—	—	.100"	1.391
3"	2.9992/2.9983"	16'	2.9983/2.9974"	12'	—	—	.100"	2.003
4"	3.9988/3.9976"	16'	3.9976/3.9964"	12'	—	—	.100"	3.560

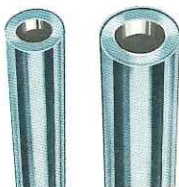
**Table #10 — Solid STAINLESS STEEL 60 Case Hardened & Ground *SHAFTS* — Material 440C**

Hardness: Rockwell 50-55C



Nominal Dia.	CLASSES OF TOLERANCE Please specify tolerance "Class" on order.		Max.* Length (Feet)	Minimum Depth of Hardness	Weight Per Inch of Length (lbs.)
	Class "L" Shaft Dia. For use with Series XA, ADJ, OPN and Normal Fit Series B	Class "S" Shaft Dia. For use with Series A and Press Fit Series B Ball Bushings			
$\frac{1}{4}$ "	.2495/.2490"	.2490/.2485"	5'	.040"	.014
$\frac{3}{8}$ "	.3745/.3740"	.3740/.3735"	12'	.040"	.031
$\frac{1}{2}$ "	.4995/.4990"	.4990/.4985"	12'	.060"	.055
$\frac{3}{4}$ "	.7495/.7490"	.7490/.7485"	12'	.060"	.125
1"	.9995/.9990"	.9990/.9985"	12'	.080"	.222
1 $\frac{1}{4}$ "	1.2495/1.2490"	1.2490/1.2485"	12'	.080"	.348
1 $\frac{1}{2}$ "	1.4994/1.4989"	1.4989/1.4984"	12'	.080"	.500
2"	1.9994/1.9987"	1.9987/1.9980"	12'	.100"	.890
2 $\frac{1}{2}$ "	2.4993/2.4985"	2.4985/2.4977"	12'	.100"	1.391

**Table #11 — TUBULAR 60 Case Hardened & Ground *SHAFTS* — Dimensions**



Nominal Dia.	Nominal I.D.	CLASSES OF TOLERANCE Please specify tolerance "Class" on order.		Max.* Length (Feet)	Minimum Depth of Hardness	Weight Per Inch of Length (lbs.)
		Class "L" Shaft Dia. For use with Series XA, ADJ, OPN and Normal Fit Series B	Class "S" Shaft Dia. For use with Series A and Press Fit Series B Ball Bushings			
1 $\frac{1}{2}$ "	.890" $\pm 5\%$	1.4994/1.4989"	1.4989/1.4984"	12'	.080"	.328
2"	1.250" $\pm 5\%$	1.9994/1.9987"	1.9987/1.9980"	12'	.100"	.542

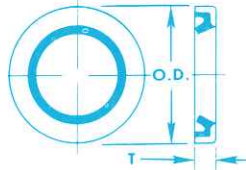
\*For longer lengths . . . please contact factory!

# BALL BUSHING SEALS— Engineering Specifications

**Table #12 — SEALS for Series A, XA & B Ball Bushings — Dimensions**

The following data is for synthetic rubber Standard BALL BUSHING Seals. Up to the S-1500 size the Seals are not spring loaded. *Low cost felt or leather seals are not stocked at present but quotations will be given for special run production quantities if desired.*

(See Page 19 for Seal Recommendations.) When ordering, specify part number to indicate type and size desired.



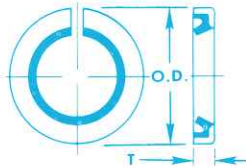
**Table #13 — STAINLESS STEEL SEALS for Series A & XA Ball Bushings**

Use With Ball Bushing No.	Nominal Shaft Dia.	Part Number	Dimensions	
			T.	O.D.
A, XA or B-4812	1/4"	S-250	.125	.504
A, XA or B-61014	3/8"	S-375	.125	.629
A, XA or B-81420	1/2"	S-500	.125	.879
A, XA or B-122026	3/4"	S-750	.125	1.254
A, XA or B-162536	1"	S-1000	.187	1.567
A, XA or B-203242	1 1/4"	S-1250	.375	2.004
A, XA or B-243848	1 1/2"	S-1500	.375	2.379
A or XA-324864	2"	S-2000	.375	3.004
A or XA-406080	2 1/2"	S-2500	.375	3.756
A or XA-487296	3"	S-3000	.500	4.506
A or XA-6496128	4"	S-4000	.500	6.006

A or XA-4812-SS	1/4"	S-250-SS	.125	.504
A or XA-61014-SS	3/8"	S-375-SS	.125	.629
A or XA-81420-SS	1/2"	S-500-SS	.125	.879
A or XA-122026-SS	3/4"	S-750-SS	.125	1.254
A or XA-162536-SS	1"	S-1000-SS	.187	1.567

**Table #14 — SEALS for Series ADJ Ball Bushings — Dimensions**

Seals for use with Adjustable Diameter Series ADJ BALL BUSHINGS are identical with those Seals used with Series A, XA and B BALL BUSHINGS *except* that they have a radial slot approximately 1/8" wide through the circumference to facilitate diameter adjustment.



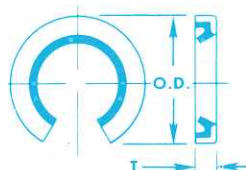
**Table #15 — STAINLESS STEEL SEALS for Series ADJ Ball Bushings**

Use With Ball Bushing No.	Nominal Shaft Dia.	Part Number	Dimensions	
			T.	O.D.
ADJ-81420	1/2"	ADJ-S-500	.125	.879
ADJ-122026	3/4"	ADJ-S-750	.125	1.254
ADJ-162536	1"	ADJ-S-1000	.187	1.567
ADJ-203242	1 1/4"	ADJ-S-1250	.375	2.004
ADJ-243848	1 1/2"	ADJ-S-1500	.375	2.379
ADJ-324864	2"	ADJ-S-2000	.375	3.004
ADJ-406080	2 1/2"	ADJ-S-2500	.375	3.756
ADJ-487296	3"	ADJ-S-3000	.500	4.506
ADJ-6496128	4"	ADJ-S-4000	.500	6.007

ADJ-81420-SS	1/2"	ADJ-S-500-SS	.125	.879
ADJ-122026-SS	3/4"	ADJ-S-750-SS	.125	1.254
ADJ-162536-SS	1"	ADJ-S-1000-SS	.187	1.567

**Table #16 — SEALS for Series OPN Ball Bushings — Dimensions**

Seals for use with Open Type Series OPN BALL BUSHINGS are similar to the Seals used with Series A, XA and B BALL BUSHINGS *except* that they have a wedge-shaped section removed to permit them to pass over shaft supports.



**Table #17 — STAINLESS STEEL SEALS for Series OPN Ball Bushings**

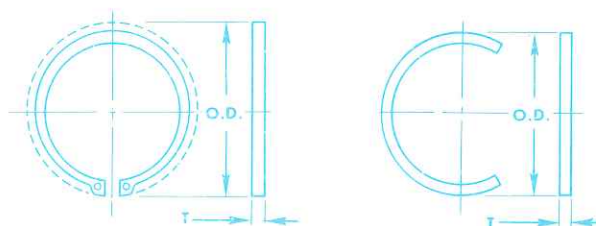
Use With Ball Bushing No.	Nominal Shaft Dia.	Part Number	Dimensions	
			T.	O.D.
OPN-81420	1/2"	OPN-S-500	.125	.879
OPN-122026	3/4"	OPN-S-750	.125	1.254
OPN-162536	1"	OPN-S-1000	.187	1.567
OPN-203242	1 1/4"	OPN-S-1250	.375	2.004
OPN-243848	1 1/2"	OPN-S-1500	.375	2.379
OPN-324864	2"	OPN-S-2000	.375	3.004
OPN-406080	2 1/2"	OPN-S-2500	.375	3.756
OPN-487296	3"	OPN-S-3000	.500	4.506
OPN-6496128	4"	OPN-S-4000	.500	6.007

OPN-81420-SS	1/2"	OPN-S-500-SS	.125	.879
OPN-122026-SS	3/4"	OPN-S-750-SS	.125	1.254
OPN-162536-SS	1"	OPN-S-1000-SS	.187	1.567

# BALL BUSHING *RETAINING RINGS* — Engineering Specifications

**Table # 18 — EXTERNAL RETAINING RINGS — Dimensions**

Two types of External Retaining Rings, as illustrated, are offered for use with BALL BUSHINGS. They are usually used to form one or two shoulders on the O.D. of the Bushing. When ordering, specify part number to indicate type and size of ring desired. *NOTE: An internal type, for use in housing bores, is available upon request but is not shown here.*



TYPE "W"  
Can be used with series  
A, XA, B and ADJ

TYPE "C"  
Can be used with series  
A, XA, B, ADJ and OPN

**Table #19 — Stainless Steel  
EXTERNAL RETAINING RINGS —**

Use With Ball Bushing No.	Part Number	Dimensions	
		T.	O.D.
A, XA or B-4812	W-250	.035	.720
	C-250	.035	.550
A, XA or B-61014	W-375	.035	.850
	C-375	.035	.673
A, XA or B-81420	W-500	.042	1.150
	C-500	.042	.923
A, XA or B-122026	W-750	.050	1.620
	C-750	.050	1.301
A, XA or B-162536	W-1000	.062	2.040
	C-1000	.062	1.620
A, XA or B-203242	W-1250	.062	2.500
	C-1250	.062	2.040
A, XA or B-243848	W-1500	.078	2.910
	C-1500	.078	2.429
A or XA-324864	W-2000	.093	3.600
A or XA-406080	W-2500	.109	4.420
A or XA-487296	W-3000	.109	5.310
A or XA-6496128	W-4000	.125	7.100

INST-258-SS	W-125-SS	.025	.495
INST-369-SS	W-187-SS	.025	.560
A, XA or Inst-4812-SS	W-250-SS	.035	.720
	C-250-SS	.035	.550
A or XA-61014-SS	W-375-SS	.035	.850
	C-375-SS	.035	.673
A or XA-81420-SS	W-500-SS	.042	1.150
	C-500-SS	.042	.923
A or XA-122026-SS	W-750-SS	.050	1.620
	C-750-SS	.050	1.301
A or XA-162536-SS	W-1000-SS	.062	2.040
	C-1000-SS	.062	1.620

# BALL BUSHING *RESILIENT MOUNTS* — Engineering Specifications

**Table #20—RESILIENT Ball Bushing MOUNTS— Dimensions**

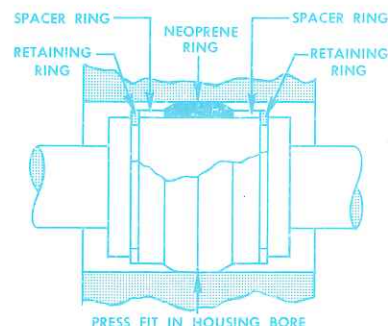
Resilient BALL BUSHING Mounts are sometimes used for installations where absolute rigidity is not essential. Some of the benefits they offer are: Self-aligning feature overcomes effects of misalignment of housing bores and shafts; They guarantee uniform load distribution over the entire length of load-carrying balls; They reduce need for precision housing bores and lessen shaft straightness requirements; Cushion support provides quiet operation and protects bearing and shaft from damage due to impact loads. *For further information see Catalog Page 20.*

Each Mount is a standard set of five pieces as shown at right: 2—Retaining Rings (C-type)  
2—Spacer Rings  
1—Neoprene Ring

Housing bore recommendations are shown in the table. Neoprene ring is a press fit which assures adequate retention in the housing bores specified. Durometer of Neoprene ring is 60.

Use With Ball Bushing No.*	Part Number Complete Assembly	Recommended Housing Bore $\pm .005"$
A, XA or B-4812	RSL-250	$\frac{5}{8}"$
A, XA or B-61014	RSL-375	$\frac{3}{4}"$
A, XA or B-81420	RSL-500	1"
A, XA or B-122026	RSL-750	$1\frac{1}{8}"$
A, XA or B-162536	RSL-1000	$1\frac{1}{2}"$
A, XA or B-203242	RSL-1250	$2\frac{1}{8}"$
A, XA or B-243848	RSL-1500	$2\frac{3}{4}"$

\*Larger sizes not available at this printing.  
Consult factory for information on availability of new types for all sizes.



**TO ORDER:** BALL BUSHINGS and Ball Bushing ACCESSORIES may be obtained from your local representative. See back of catalog for name and address.

# COMBINATION BEARINGS—Engineering Specifications

For combined *linear-rotary* motion, radial anti-friction bearings may be mounted on the outside diameter of Ball Bushings as described on Page 20.

To assist customers who wish to use Combination Bearings for linear-rotary motion, Thomson Industries, Inc. will furnish combination bearing sets suitable for mounting on the outside diameter of Series INST, A, XA or B BALL BUSHINGS. Each set will consist of five pieces:

- 2—Retaining Rings
- 2—Spacer Rings
- 1—Radial Anti-friction Bearing

Table 21 lists part numbers and housing bore dimensions for combination bearing sets. For more specific recommendations concerning the use of BALL BUSHINGS and radial bearings for combined motions, contact your local representative whose name is shown on the back cover of this catalog . . . or phone or write the factory direct.

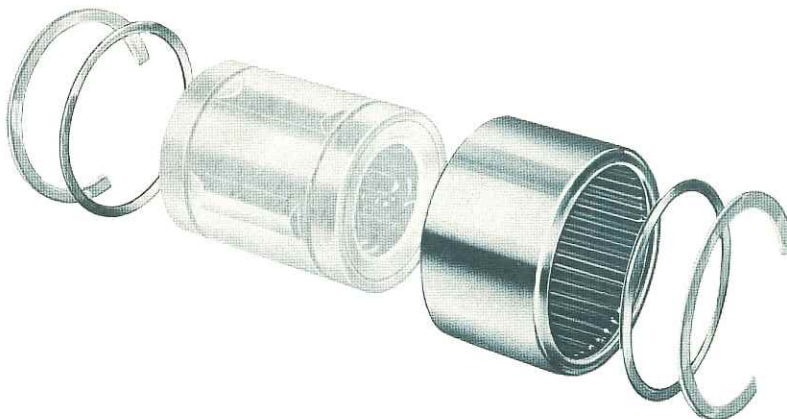
**TABLE #21 — COMBINATION BEARING SETS — DIMENSIONS**

USE WITH BALL BUSHING NO.	COMBINATION BEARING SET NO.	RECOMMENDED HOUSING BORE FOR PRESS FIT OF RADIAL BEARING TOL. +.001 —.000	LENGTH OF RADIAL BEARING
INST-258-SS	CMB-125	.4995"	5/16"*
INST-369-SS	CMB-187	.5620"	5/16"
INST-4812-SS	CMB-250	.6870"	3/8"
A,XA or B-4812	CMB-250	.6870"	3/8"
A,XA or B-61014	CMB-375	.8120"	1/2"
A,XA or B-81420	CMB-500	1.1245"	3/4"
A,XA or B-122026	CMB-750	1.4995"	1"
A,XA or B-162536	CMB-1000	2.1234"	1 1/4"
A,XA or B-203242	CMB-1250	2.3745"	1 3/4"
A,XA or B-243848	CMB-1500	3.7482"	1 3/4"
A or XA-324864	CMB-2000	3.7482"	1 3/4"
A or XA-406080	CMB-2500	4.7482"	2"
A or XA-487296	CMB-3000	5.9980"	2 1/4"
A or XA-6496128	CMB-4000	7.4976"	3"

\*No spacer rings required for INST-258-SS only.



**External View of "Combination" Ball Bushing & Anti-Friction Radial Bearing**



**Exploded View of "Combination" Ball Bushing & Anti-Friction Radial Bearing**

# TYPICAL BALL BUSHING APPLICATIONS

Following is a partial list of machines and mechanisms which **USE BALL BUSHINGS**. It illustrates the extremely broad field of applications for which **BALL BUSHINGS** offer important benefits. Numerous other applications, where **BALL BUSHINGS** can be used to advantage, exist in every factory and in many products.

A review of plant equipment and product applications will reward alert engineers . . . by bringing them improvements which result from using **BALL BUSHINGS** instead of sleeve bearings, sliding ways and clumsy wheel and track devices.

## Machine Tools

Radial Arm Routers  
Multiple-Spindle Drilling Machines  
Milling Cutter Grinders  
Contour-Matic Band Saws  
Spot Welders — Air Operated Press Type  
Automatic Cylindrical Grinders — Compound Slide  
Automobile Cylinder Block Hones  
Broaching Machines  
Bit and Broach Grinders  
Spline Milling Machines  
Roll-in Band Saws  
Contour Milling Machines  
Turning and Brushing Lathes  
Radial Arm Milling Machines  
Power Cut-Off Saws  
Bench Surface Grinders  
Radial Arm Circular Saws  
Metal Distintegrators  
Guillotine Pipe Saws

## Tools

Automatic Glass Cutters  
Machine Tool Tracers  
Punch Press Duplicators  
Pantograph Roll Engravers  
Plate Glass Bevelers  
Portable Core Box Routers  
Saw Trimmers  
Pneumatic Nut Runners  
Roller Lapping Machines  
Stripper Slide for Automatic Drilling Machines  
Radius Gauge Lappers

## Electronic & Electric

Waveguide Test Instruments  
Transducer Waveguide Carriages  
Constant Voltage Transformers  
Commercial Radio Transmitters  
Tuning Devices for Radar  
Electronic Tube Grid Winders

## Aircraft & Missiles

Accelerometers  
Navigational Systems  
Photographic View Finders  
Aircraft Trainers (Simulators)  
Channel Selector Devices  
Fuel Control Devices  
Adjustable Pilot's Seats  
Loading Ramps  
In-Flight Refueling Reel Units  
Negative "G" Shut-off Valves  
Fire Seal Bushings  
Push-Pull Controls

## Special Machinery

Labeling & Packing Machines  
Printing Machines  
Carton Folding Machines  
Cardboard Tube Formers  
Roll Winding Centering Devices  
Paper Folding Machines  
Bottle Making Machines  
Type Trimming & Mitering Saws (Printing)  
Embroidering Machines  
Silk-Screen Printing Machines  
TV Picture Tube Sealing Machines  
Air & Hydraulic Cylinders

## Gauge Instruments & Controls

Conju-Gauge Gear Checkers  
Optical Projection Gauges  
Air-O-Limit Gauges  
Indicating Dial Gauges  
Electro-Limit Gauges  
Brake Pedal Pressure Gauges  
Elevator Control Devices  
Jet Engine Thrust Meters  
Oil Field Logging Equipment  
Compressor Control Devices  
Speed Controls, Diesel Motor Generators  
Wheel Alignment Checkers  
Textile & Wire Testing Recorders  
X-Y Axis Plotters and Recorders  
Electronics Components Assembly Machines  
Force Indicators  
Cartesian Manostats  
Water Level Recorders

## Business Machines

Collators  
Portable Micro-Film Cameras  
Check Holders  
Check Perforators  
Tape Recorders  
Drum Type Dictating Machines  
Univac — Electronic Brain  
Comptometers  
Carton Mailers  
Card Selection Mechanisms

## Food Machines

Hamburger Patty Makers  
Fruit Packing Machines  
Hot Plate Dispensers  
Meat Wrapping Machines  
Meat Slicers  
Bread Slicing Band Sharpeners

## Textile Machines

Twister Frame Lifter Rods  
Automatic Pirn Winders  
Spinning Frame Twister Tube  
Bracket Arms  
Cloth Cutter Knife Sharpeners  
Textile Heads for Ballers  
Quilting Machines — Needle Bar Guide

## Miscellaneous

Automatic Bowling Pin Setters  
Projection Readers  
X-Ray Plate Traversing Units  
Lettering Machines  
Isometric and Diametric Drafting Machines  
Television Camera Lens Mounts  
Sign Duplicator Printers  
Price Tag Taggers  
Color Film Multi-printers  
Paint Color Comparators  
Camera Lens and Reflector Carriages  
Brake Test Units  
Hospital Beds  
Floating Motor Mounts

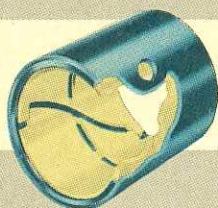
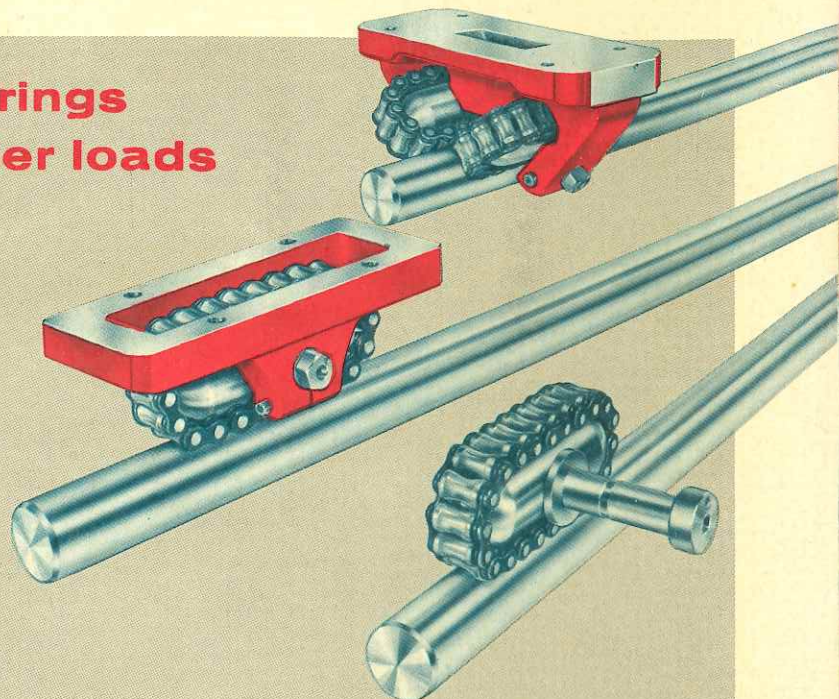
Engineered to **SOLVE PROBLEMS . . . IMPROVE PRODUCTS . . . REDUCE COSTS**



**PROGRESSIVE MANUFACTURERS  
USE BALL BUSHINGS**  
**A MAJOR IMPROVEMENT AT A MINOR COST**

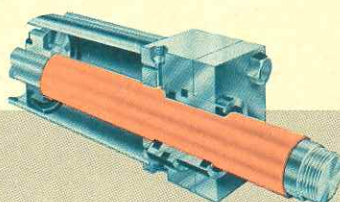
## ROUNDWAY® Bearings and WAYS...for heavier loads

Invented by Thomson Industries, Inc., the ROUNDWAY Bearing combined with hardened and ground Round Ways presents a basic new concept in machinery ways. The ROUNDWAY Bearing is the high capacity anti-friction, recirculating, linear roller bearing designed for use on hardened and ground Round Ways. It eliminates friction, wear and stick-slip at low cost. The economy of continuous high speed thru feed centerless grinding of round ways makes them much less expensive than flat ways. Super precision is easily obtained by a simple adjustment. Greater load capacity results from a self-aligning feature which guarantees uniform load distribution. Adjustable height and self-alignment in every direction provide for easy installation. Spaced rollers which cannot rub or skew assure lowest friction and wear. Simple inversion of bearing race doubles life. Bearings and Round Ways are both stocked for prompt shipment. Ways are easily replaced in event of wear or damage. Quality and performance are guaranteed.



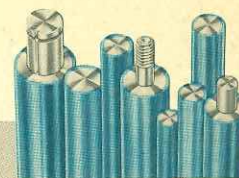
### NYLINED BEARINGS

NYLINED Bearings, another important FIRST by Thomson Industries, Inc., are designed to offer the recognized advantages of DuPont Nylon as a bearing material and as a solution to most of the limitations surrounding its use. The Nylon liner (NYLINER) is supplied in a metal shell or separately for direct mounting in housings. Standard sizes are stocked in both the plain and flanged types. These bearings are most often used to reduce cost and eliminate lubrication. The resiliency of the NYLINER resists poundout, minimizes abrasion failures and assures silent operation. Their corrosion resistance enables them to operate in most liquids and prevents contamination and friction oxidation. These compact bearings can be closely fitted for precision low friction applications. They are simple to install and are instantly replaceable.



### BRONZE Case

Another development by Thomson Industries, Inc., BRONZE Case puts the bearing material where it belongs . . . on the big surface! In either linear or rotary applications the bearing surface is vastly increased which produces many important benefits. Bushing replacement cost is reduced. Downtime production losses are reduced. Lubrication is reduced. Size and weight are reduced. Operating efficiency is improved. Stick-slip and chatter are reduced. Rust and nick troubles are eliminated. Bronze bearing and installation costs are eliminated. Bronze bearing material is fused on the steel rod which is ground and straightened to close tolerances. It is where it belongs . . . on the big surface.



### General Purpose 60 Case

60 Case Shafts are manufactured in 18 standard sizes and three tolerance ranges for general industrial use. They are furnished in random lengths, cut to length and with or without special machining. Delivery is fast. These wear resistant hardened and ground Shafts avoid the high cost and difficulty of fabricating long, hard, and straight parts by conventional methods. In the past, it has been very difficult and expensive to apply the recognized advantages of hardening to long slender shafts because of warpage. 60 Case solves this problem. 60 Case is the result of years of experimental work and production experience with hardened and ground Shafts which are used with the BALL BUSHING and ROUNDWAY Bearing. The special techniques and equipment that have been developed enable high production rates and low handling costs.

YOUR LOCAL REPRESENTATIVE IS:

**SPECIALTIES, INC.**  
P. O. BOX 2062  
ALEXANDRIA, VIRGINIA

**THOMSON  
INDUSTRIES, INC.**

MANHASSET, NEW YORK

# BALL BUSHING SMALL QUANTITY NET PRICES

# PRICE LIST No. 8

Effective January 1, 1963

All prices listed are net. For quotations on larger quantities or any other information contact your local sales representative whose name is shown on back of catalog or phone or write factory direct.

TO ORDER: BALL BUSHINGS and Ball Bushing ACCESSORIES may be obtained from your local sales representative who is also your stocking distributor. See back of catalog for name and address.

**Table A — PRECISION Series A Ball Bushings**

Bushing Number	Nominal Shaft Dia.	QUANTITY										Bushing Number
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
A-4812	1/4"	\$ 4.45	4.30	4.15	4.00	3.85	3.75	3.65	3.55	3.45	3.35	A-4812
A-61014	3/8"	4.85	4.70	4.55	4.40	4.25	4.15	4.05	3.95	3.85	3.75	A-61014
A-81420	1/2"	5.10	4.95	4.80	4.65	4.50	4.40	4.30	4.20	4.10	4.00	A-81420
A-122026	3/4"	5.95	5.75	5.55	5.35	5.15	4.95	4.80	4.65	4.50	4.35	A-122026
A-162536	1"	10.70	10.40	10.10	9.80	9.50	9.20	8.90	8.60	8.30	8.00	A-162536
A-203242	1 1/4"	18.25	17.70	17.15	16.60	16.05	15.50	15.00	14.50	14.00	13.50	A-203242
A-243848	1 1/2"	20.75	20.15	19.55	18.95	18.35	17.75	17.15	16.55	15.95	15.35	A-243848
A-324864	2"	36.30	35.20	34.10	33.10	32.10	31.10	30.10	29.10	28.10	27.10	A-324864
A-406080	2 1/2"	60.50	58.80	57.10	55.40	53.70	52.00	50.35	48.70	47.05	45.40	A-406080
A-487296	3"	97.15	94.45	91.75	89.05	86.35	83.65	80.95	78.25	75.55	72.85	A-487296
A-6496128	4"	194.45	189.30	184.15	179.00	173.85	168.70	163.55	158.40	153.25	148.10	A-6496128

**Table B — SUPER PRECISION Series XA Ball Bushings**

Bushing Number	Nominal Shaft Dia.	QUANTITY										Bushing Number
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
XA-4812	1/4"	\$ 7.50	7.30	7.10	6.90	6.70	6.50	6.30	6.10	5.90	5.70	XA-4812
XA-61014	3/8"	7.70	7.50	7.30	7.10	6.90	6.70	6.50	6.30	6.10	5.90	XA-61014
XA-81420	1/2"	8.05	7.80	7.55	7.30	7.10	6.90	6.70	6.50	6.30	6.10	XA-81420
XA-122026	3/4"	9.65	9.35	9.05	8.75	8.45	8.20	7.95	7.70	7.45	7.20	XA-122026
XA-162536	1"	15.70	15.25	14.80	14.35	13.90	13.45	13.00	12.60	12.20	11.80	XA-162536
XA-203242	1 1/4"	24.05	23.35	22.65	21.95	21.25	20.55	19.90	19.25	18.60	17.95	XA-203242
XA-243848	1 1/2"	26.75	26.00	25.25	24.50	23.75	23.00	22.25	21.50	20.75	20.00	XA-243848
XA-324864	2"	44.90	43.65	42.40	41.15	39.90	38.65	37.40	36.15	34.90	33.65	XA-324864
XA-406080	2 1/2"	73.20	71.15	69.10	67.05	65.00	62.95	60.90	58.85	56.80	54.75	XA-406080
XA-487296	3"	114.45	111.25	108.05	104.85	101.65	98.45	95.25	92.05	88.85	85.65	XA-487296
XA-6496128	4"	228.00	222.00	216.00	210.00	204.00	198.00	192.00	186.00	180.00	174.00	XA-6496128

**Table C — ADJUSTABLE DIAMETER Series ADJ Ball Bushings**

Bushing Number	Nominal Shaft Dia.	QUANTITY										Bushing Number
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
ADJ-81420	1/2"	\$ 7.00	6.80	6.60	6.40	6.20	6.05	5.90	5.75	5.60	5.45	ADJ-81420
ADJ-122026	3/4"	7.85	7.60	7.40	7.20	7.00	6.80	6.60	6.40	6.20	6.00	ADJ-122026
ADJ-162536	1"	14.35	13.85	13.35	12.85	12.35	11.85	11.35	10.90	10.45	10.00	ADJ-162536
ADJ-203242	1 1/4"	23.45	22.75	22.05	21.35	20.65	19.95	19.25	18.55	17.85	17.15	ADJ-203242
ADJ-243848	1 1/2"	26.55	25.75	24.95	24.15	23.35	22.55	21.75	21.00	20.25	19.50	ADJ-243848
ADJ-324864	2"	46.00	44.65	43.30	42.00	40.70	39.40	38.10	36.80	35.50	34.20	ADJ-324864
ADJ-406080	2 1/2"	76.35	74.25	72.15	70.05	67.95	65.85	63.75	61.65	59.55	57.45	ADJ-406080
ADJ-487296	3"	117.30	114.00	110.70	107.40	104.10	100.80	97.50	94.20	90.90	87.60	ADJ-487296
ADJ-6496128	4"	225.45	219.45	213.45	207.45	201.45	195.45	189.45	183.45	177.45	171.45	ADJ-6496128

**Table D — OPEN TYPE Series OPN Ball Bushings**

Bushing Number	Nominal Shaft Dia.	QUANTITY										Bushing Number
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
OPN-81420	1/2"	\$ 7.00	6.80	6.60	6.40	6.20	6.00	5.85	5.70	5.55	5.40	OPN-81420
OPN-122026	3/4"	7.75	7.55	7.35	7.15	6.95	6.75	6.55	6.35	6.15	5.95	OPN-122026
OPN-162536	1"	14.15	13.65	13.15	12.65	12.15	11.65	11.20	10.75	10.30	9.85	OPN-162536
OPN-203242	1 1/4"	23.20	22.45	21.70	21.00	20.30	19.60	18.90	18.20	17.50	16.80	OPN-203242
OPN-243848	1 1/2"	26.15	25.35	24.55	23.75	22.95	22.15	21.40	20.65	19.90	19.15	OPN-243848
OPN-324864	2"	45.15	43.85	42.55	41.30	40.05	38.80	37.55	36.30	35.05	33.80	OPN-324864
OPN-406080	2 1/2"	75.00	72.95	70.90	68.85	66.80	64.75	62.70	60.65	58.65	56.65	OPN-406080
OPN-487296	3"	115.00	111.90	108.80	105.70	102.60	99.50	96.40	93.30	90.20	87.10	OPN-487296
OPN-6496128	4"	221.85	215.85	209.85	203.85	197.85	191.85	185.85	179.85	173.85	167.85	OPN-6496128

**Table E — INTERCHANGEABLE Die-Set Series DS Ball Bushings**

Bushing Number	Nominal Shaft Dia.	QUANTITY										Bushing Number
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
DS-16	1"	\$17.90	17.40	16.90	16.40	15.90	15.40	14.90	14.40	13.90	13.40	DS-16
DS-20	1 1/4"	21.45	20.85	20.25	19.65	19.05	18.45	17.85	17.25	16.65	16.05	DS-20
DS-24	1 1/2"	25.20	24.50	23.80	23.10	22.40	21.70	21.00	20.30	19.60	18.90	DS-24
DS-32	2"	41.65	40.50	39.35	38.20	37.05	35.90	34.75	33.60	32.45	31.30	DS-32

# BALL BUSHING SMALL QUANTITY NET PRICES

**Table F — INSTRUMENT Series INST-SS Ball Bushings**



Bushing Number	Nominal Shaft Dia.	QUANTITY										Bushing Number
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
INST-258-SS	1/8"	\$18.45	17.90	17.35	16.80	16.25	15.70	15.15	14.60	14.05	13.50	INST-258-SS
INST-369-SS	3/16"	18.45	17.90	17.35	16.80	16.25	15.70	15.15	14.60	14.05	13.50	INST-369-SS
INST-4812-SS	1/4"	18.45	17.90	17.35	16.80	16.25	15.70	15.15	14.60	14.05	13.50	INST-4812-SS

*MATERIALS: Stainless Steel Sleeve and Balls; Brass Retainer.*

**Table G — PRECISION Series A-SS All Stainless Steel Ball Bushings**



Bushing Number	Nominal Shaft Dia.*	QUANTITY										Bushing Number
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
A-4812-SS	1/4"	\$ 7.90	7.65	7.40	7.15	6.95	6.75	6.55	6.35	6.15	5.95	A-4812-SS
A-61014-SS	3/8"	8.50	8.25	8.05	7.85	7.65	7.45	7.25	7.05	6.85	6.65	A-61014-SS
A-81420-SS	1/2"	9.45	9.15	8.85	8.55	8.30	8.05	7.80	7.55	7.30	7.05	A-81420-SS
A-122026-SS	3/4"	11.80	11.45	11.10	10.75	10.40	10.05	9.75	9.45	9.15	8.85	A-122026-SS
A-162536-SS	1"	26.75	26.00	25.25	24.50	23.75	23.00	22.25	21.50	20.75	20.00	A-162536-SS

**Table H — SUPER PRECISION Series XA-SS All Stainless Steel Ball Bushings**



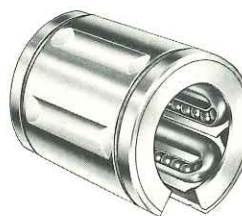
Bushing Number	Nominal Shaft Dia.*	QUANTITY										Bushing Number
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
XA-4812-SS	1/4"	\$12.00	11.65	11.30	10.95	10.60	10.30	10.00	9.70	9.40	9.10	XA-4812-SS
XA-61014-SS	3/8"	12.85	12.50	12.15	11.80	11.45	11.10	10.75	10.40	10.10	9.80	XA-61014-SS
XA-81420-SS	1/2"	13.40	13.00	12.60	12.25	11.90	11.55	11.20	10.85	10.50	10.15	XA-81420-SS
XA-122026-SS	3/4"	16.00	15.55	15.10	14.65	14.20	13.75	13.30	12.90	12.50	12.10	XA-122026-SS
XA-162536-SS	1"	32.80	31.85	30.90	29.95	29.05	28.15	27.25	26.35	25.45	24.55	XA-162536-SS

**Table J — ADJUSTABLE DIAMETER Series ADJ-SS All Stainless Steel Ball Bushings**



Bushing Number	Nominal Shaft Dia.*	QUANTITY										Bushing Number
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
ADJ-81420-SS	1/2"	\$11.35	11.00	10.65	10.30	10.00	9.70	9.40	9.10	8.80	8.50	ADJ-81420-SS
ADJ-122026-SS	3/4"	13.70	13.35	13.00	12.65	12.30	11.95	11.60	11.25	10.90	10.55	ADJ-122026-SS
ADJ-162536-SS	1"	30.40	29.45	28.50	27.55	26.60	25.65	24.70	23.80	22.90	22.00	ADJ-162536-SS

**Table K — OPEN TYPE Series OPN-SS All Stainless Steel Ball Bushings**



Bushing Number	Nominal Shaft Dia.*	QUANTITY										Bushing Number
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
OPN-81420-SS	1/2"	\$11.30	10.95	10.60	10.25	9.95	9.65	9.35	9.05	8.75	8.45	OPN-81420-SS
OPN-122026-SS	3/4"	13.65	13.30	12.95	12.60	12.25	11.90	11.55	11.20	10.85	10.50	OPN-122026-SS
OPN-162536-SS	1"	30.25	29.30	28.35	27.40	26.45	25.50	24.55	23.65	22.75	21.85	OPN-162536-SS

\*Larger sizes of Series A-SS, XA-SS, ADJ-SS and OPN-SS in all-Stainless Steel are available on an individual tool room hand made basis. For limited protection against atmospheric corrosion larger sizes can also be supplied with Stainless Steel balls and with other components having black oxide surface protection.

## COMMERCIAL GRADE Series B Ball Bushings



Series B BALL BUSHINGS have been developed for use in competitively priced production products. To offer the lowest possible price these bearings are produced for specific orders and sold only for quantity shipment direct from the factory in lots of 250 or more. These bearings are not stocked by our local representative but he will be pleased to accept production orders for direct factory shipment. Trial quantities of Series B BALL BUSHINGS will be furnished for production applications which may eventually use the minimum quantity or more. Contact our local representative for recommendations and a quotation.

# BALL BUSHING ACCESSORIES—PRICE INFORMATION

2 RETAINING RINGS

2 SPACER RINGS\*

1 RADIAL ANTI-FRICTION BEARING

BALL BUSHING not included in "set."  
Please order as separate basic component.

For COMBINED LINEAR-ROTARY motion, radial anti-friction bearings may be mounted on the outside diameter of BALL BUSHINGS as described in detail on Catalog Pages 20 and 33. Combination Bearing Sets consist of five (5) pieces suitable for mounting on Series A, XA, B or INST Ball Bushings.\* Assembly of the Combination Bearing Set is a simple matter to be done by customer prior to installation.

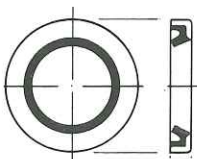
**Table L — COMBINATION Bearings SETS**

Combination Bearing Set No.	Nominal Shaft Dia.	Use with Ball Bushing No.	QUANTITY										Use With Ball Bushing No.
			1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-249	
CMB-125	1/8"	INST-258-SS	\$ 1.35	1.35	1.30	1.25	1.25	1.20	1.15	1.10	1.10	1.05	INST-258-SS
CMB-187	3/16"	INST-369-SS	1.50	1.45	1.45	1.40	1.35	1.30	1.25	1.20	1.15	1.10	INST-369-SS
CMB-250	1/4"	INST-4812-SS	1.60	1.55	1.55	1.50	1.45	1.40	1.35	1.30	1.25	1.20	INST-4812-SS
CMB-375	3/8"	A, XA or B-4812	1.60	1.55	1.55	1.50	1.45	1.40	1.35	1.30	1.25	1.20	A, XA or B-4812
CMB-500	1/2"	A, XA or B-61014	1.70	1.70	1.65	1.60	1.55	1.50	1.45	1.40	1.35	1.30	A, XA or B-61014
CMB-750	3/4"	A, XA or B-81420	1.90	1.85	1.80	1.75	1.70	1.65	1.60	1.55	1.50	1.45	A, XA or B-81420
CMB-1000	1"	A, XA or B-122026	2.50	2.40	2.30	2.25	2.20	2.15	2.10	2.05	2.00	1.95	A, XA or B-122026
CMB-1250	1 1/4"	A, XA or B-162536	11.55	11.20	10.90	10.60	10.30	10.00	9.70	9.40	9.10	8.80	A, XA or B-162536
CMB-1500	1 1/2"	A, XA or B-203242	5.05	4.90	4.75	4.60	4.45	4.30	4.15	4.05	3.95	3.85	A, XA or B-203242
CMB-2000	2"	A, XA or B-243848	26.25	25.55	24.85	24.15	23.45	22.75	22.05	21.35	20.65	20.00	A, XA or B-243848
CMB-2500	2 1/2"	A or XA-324864	23.10	22.45	21.80	21.20	20.60	20.00	19.40	18.80	18.20	17.60	A or XA-324864
CMB-3000	3"	A or XA-406080	34.45	33.50	32.55	31.65	30.75	29.85	28.95	28.05	27.15	26.25	A or XA-406080
CMB-4000	4"	A or XA-487296	64.50	62.75	61.00	59.30	57.60	55.90	54.20	52.50	50.80	49.10	A or XA-487296
		A or XA-6496128	131.50	128.00	124.50	121.00	117.50	114.00	110.50	107.00	103.50	100.00	A or XA-6496128

\*Spacer Rings not required for INST-258-SS

**Table M — SEALS for Series A, XA & B Ball Bushings**

The following data is for synthetic rubber Standard BALL BUSHING Seals. Up to the S-1500 size the Seals are not spring loaded. Low cost felt or leather seals are not stocked at present but quotations will be given for special run production quantities if desired.



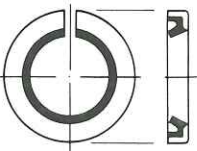
Part No.	Use with Ball Bushing No.	Nom. Shaft Dia.	QUANTITY								Use with Ball Bushing No.
			1-9	10-49	50-99	100-199	200-299	300-499	500-999	1000-4999	
S-250	A, XA or B-4812	1/4"	\$0.40	.35	.33	.28	.23	.19	.17	.15	A, XA or B-4812
S-375	A, XA or B-61014	3/8"	.40	.35	.33	.28	.23	.19	.17	.15	A, XA or B-61014
S-500	A, XA or B-81420	1/2"	.40	.35	.33	.28	.23	.19	.17	.15	A, XA or B-81420
S-750	A, XA or B-122026	3/4"	.40	.35	.33	.28	.23	.19	.17	.15	A, XA or B-122026
S-1000	A, XA or B-162536	1"	.45	.40	.35	.30	.25	.21	.19	.17	A, XA or B-162536
S-1250	A, XA or B-203242	1 1/4"	1.05	.90	.80	.70	.60	.50	.40	.35	A, XA or B-203242
S-1500	A, XA or B-243848	1 1/2"	1.20	1.05	.95	.85	.70	.55	.45	.40	A, XA or B-243848
S-2000	A or XA-324864	2"	1.45	1.25	1.15	.95	.80	.65	.55	.45	A or XA-324864
S-2500	A or XA-406080	2 1/2"	1.95	1.60	1.50	1.30	1.05	.85	.75	.65	A or XA-406080
S-3000	A or XA-487296	3"	2.60	2.20	2.05	1.75	1.45	1.15	1.05	—	A or XA-487296
S-4000	A or XA-6496128	4"	4.80	4.10	3.85	3.30	2.70	2.20	2.00	—	A or XA-6496128

**Table N — Stainless Steel SEALS for Series A & XA Ball Bushings**

S-250-SS	A or XA-4812-SS	1/4"	\$0.80	.70	.66	.56	.46	.38	.34	.30	A or XA-4812-SS
S-375-SS	A or XA-61014-SS	3/8"	.80	.70	.66	.56	.46	.38	.34	.30	A or XA-61014-SS
S-500-SS	A or XA-81420-SS	1/2"	.80	.70	.66	.56	.46	.38	.34	.30	A or XA-81420-SS
S-750-SS	A or XA-122026-SS	3/4"	.80	.70	.66	.56	.46	.38	.34	.30	A or XA-122026-SS
S-1000-SS	A or XA-162536-SS	1"	.90	.80	.70	.60	.50	.42	.38	.34	A or XA-162536-SS

**Table O — SEALS for Series ADJ Ball Bushings**

Seals for use with Adjustable Diameter Series ADJ BALL BUSHINGS are identical with those Seals used with Series A, XA and B BALL BUSHINGS except that they have a radial slot approximately 1/8" wide through the circumference to facilitate diameter adjustment.



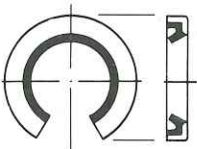
Part No.	Use With Ball Bushing No.	Nom. Shaft Dia.	QUANTITY								Use With Ball Bushing No.
			1-9	10-49	50-99	100-199	200-299	300-499	500-999	1000-4999	
ADJ-S-500	ADJ-81420	1/2"	\$0.50	.45	.40	.35	.29	.24	.21	.19	ADJ-81420
ADJ-S-750	ADJ-122026	3/4"	.50	.45	.40	.35	.29	.24	.21	.19	ADJ-122026
ADJ-S-1000	ADJ-162536	1"	.55	.50	.45	.38	.31	.26	.24	.21	ADJ-162536
ADJ-S-1250	ADJ-203242	1 1/4"	1.30	1.10	1.00	.90	.75	.62	.50	.44	ADJ-203242
ADJ-S-1500	ADJ-243848	1 1/2"	1.50	1.30	1.20	1.05	.88	.70	.56	.50	ADJ-243848
ADJ-S-2000	ADJ-324864	2"	1.80	1.55	1.45	1.20	1.00	.80	.70	.56	ADJ-324864
ADJ-S-2500	ADJ-406080	2 1/2"	2.45	2.00	1.85	1.60	1.30	1.05	.95	.80	ADJ-406080
ADJ-S-3000	ADJ-487296	3"	3.25	2.75	2.55	2.20	1.80	1.45	1.30	—	ADJ-487296
ADJ-S-4000	ADJ-6496128	4"	6.00	5.10	4.80	4.10	3.40	2.75	2.50	—	ADJ-6496128

**Table P — Stainless Steel SEALS for Series ADJ Ball Bushings**

ADJ-S-500-SS	ADJ-81420-SS	1/2"	\$0.98	.86	.80	.68	.56	.47	.41	.35	ADJ-81420-SS
ADJ-S-750-SS	ADJ-122026-SS	3/4"	.98	.86	.80	.68	.56	.47	.41	.35	ADJ-122026-SS
ADJ-S-1000-SS	ADJ-162536-SS	1"	1.15	1.03	.96	.82	.68	.55	.48	.41	ADJ-162536-SS

**Table Q — SEALS for Series OPN Ball Bushings**

Seals for use with Open Type Series OPN BALL BUSHINGS are similar to the Seals used with Series A, XA and B BALL BUSHINGS except that they have a wedge-shaped section removed to permit them to pass over shaft supports.



Part No.	Use With Ball Bushing No.	Nom. Shaft Dia.	QUANTITY								Use With Ball Bushing No.
			1-9	10-49	50-99	100-199	200-299	300-499	500-999	1000-4999	
OPN-S-500	OPN-81420	1/2"	\$0.50	.45	.40	.35	.29	.24	.21	.19	OPN-81420
OPN-S-750	OPN-122026	3/4"	.50	.45	.40	.35	.29	.24	.21	.19	OPN-122026
OPN-S-1000	OPN-162536	1"	.55	.50	.45	.38	.31	.26	.24	.21	OPN-162536
OPN-S-1250	OPN-203242	1 1/4"	1.30	1.10	1.00	.90	.75	.62	.50	.44	OPN-203242
OPN-S-1500	OPN-243848	1 1/2"	1.50	1.30	1.20	1.05	.88	.70	.56	.50	OPN-243848
OPN-S-2000	OPN-324864	2"	1.80	1.55	1.45	1.20	1.00	.80	.70	.56	OPN-324864
OPN-S-2500	OPN-406080	2 1/2"	2.45	2.00	1.85	1.60	1.30	1.05	.95	.80	OPN-406080
OPN-S-3000	OPN-487296	3"	3.25	2.75	2.55	2.20	1.80	1.45	1.30	—	OPN-487296
OPN-S-4000	OPN-6496128	4"	6.00	5.10	4.80	4.10	3.40	2.75	2.50	—	OPN-6496128

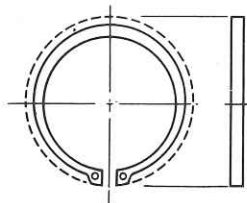
**Table R — Stainless Steel SEALS for Series OPN Ball Bushings**

OPN-S-500-SS	OPN-81420-SS	1/2"	\$0.98	.86	.80	.68	.56	.47	.41	.35	OPN-81420-SS
OPN-S-750-SS	OPN-122026-SS	3/4"	.98	.86	.80	.68	.56	.47	.41	.35	OPN-122026-SS
OPN-S-1000-SS	OPN-162536-SS	1"	1.15	1.03	.96	.82	.68	.55	.48	.41	OPN-162536-SS

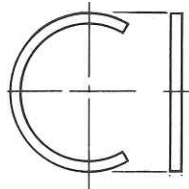
(See Catalog Page 19 for Seal recommendations.)

## BALL BUSHING ACCESSORIES—PRICE INFORMATION

**Table S — EXTERNAL RETAINING RINGS**



TYPE "W"  
Can be used with Series  
A, XA, B, ADJ and INST



TYPE "C"  
Can be used with Series  
A, XA, B, ADJ, OPN and INST

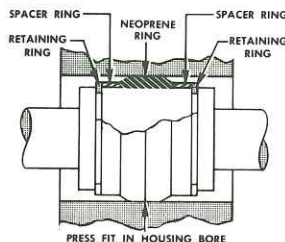
Two types of External Retaining Rings, as illustrated, are offered for use with BALL BUSHINGS. They are usually used to form one or two shoulders on the O.D. of the Bushing. When ordering, specify part number to indicate type and size of ring desired. *NOTE: An internal type, for use in housing bores, is available upon request but is not shown here. Prices are the same as for the external type. For further information see Catalog Page 32.*

**Table T — Stainless Steel  
EXTERNAL RETAINING RINGS →**

Part Number	Use With Ball Bushing No.	(EACH) 1 to 99	PRICE PER THOUSAND			Use With Ball Bushing No.
			100 to 499	500 to 999	1000 to 4999	
W-250	4812	\$0.04 ea.	22.00	17.00	13.00	4812
C-250		.04 ea.	22.00	17.00	13.00	
W-375	61014	.05 ea.	24.00	19.00	15.00	61014
C-375		.05 ea.	24.00	19.00	15.00	
W-500	81420	.06 ea.	32.00	23.00	19.00	81420
C-500		.06 ea.	32.00	23.00	19.00	
W-750	122026	.09 ea.	48.00	34.00	29.00	122026
C-750		.09 ea.	48.00	34.00	29.00	
W-1000	162536	.15 ea.	77.00	55.00	45.00	162536
C-1000		.15 ea.	77.00	55.00	45.00	
W-1250	203242	.20 ea.	108.00	92.00	64.00	203242
C-1250		.20 ea.	108.00	92.00	64.00	
W-1500	243848	.36 ea.	183.00	148.00	115.00	243848
C-1500		.36 ea.	183.00	148.00	115.00	
W-2000	324864	.63 ea.	317.00	258.00	199.00	324864
W-2500	406080	1.15 ea.	576.00	497.00	475.00	406080
W-3000	487296	1.50 ea.	1080.00	960.00	840.00	487296
W-4000	6496128	2.20 ea.	1490.00	1440.00	1325.00	6496128

W-125-SS	258-SS	\$0.21 ea.	97.00	78.00	70.00	258-SS
W-187-SS	369-SS	.21 ea.	97.00	78.00	73.00	369-SS
W-250-SS	4812-SS	.21 ea.	97.00	78.00	75.00	4812-SS
C-250-SS		.21 ea.	97.00	78.00	71.00	
W-375-SS	61014-SS	.22 ea.	110.00	98.00	89.00	61014-SS
C-375-SS		.21 ea.	97.00	78.00	71.00	
W-500-SS	81420-SS	.29 ea.	140.00	125.00	114.00	81420-SS
C-500-SS		.21 ea.	97.00	78.00	71.00	
W-750-SS	122026-SS	.43 ea.	210.00	190.00	180.00	122026-SS
C-750-SS		.25 ea.	120.00	98.00	78.00	
W-1000-SS	162536-SS	.55 ea.	288.00	275.00	264.00	162536-SS
C-1000-SS		.30 ea.	140.00	115.00	95.00	

**Table U — RESILIENT Ball Bushing MOUNTS**



Resilient BALL BUSHING Mounts are sometimes used for installations where absolute rigidity is not essential. Some of the benefits they offer are: Self-aligning feature overcomes effects of misalignment of housing bores and shafts. They guarantee uniform load distribution over the entire length of load-carrying balls. They reduce need for precision housing bores and lessen shaft straightness requirements. Cushion support provides quiet operation and protects bearing and shaft from damage due to impact loads. *For further information see Catalog Pages 20 and 32.*

Resilient Mount Set No.	Use with Ball Bushing No.	QUANTITY (PRICE EACH)							
		1-9	10-49	50-99	100-199	200-299	300-499	500-999	1000-4999
RSL-250	A, XA or B-4812	\$0.95	.85	.65	.55	.45	.40	.35	.28
RSL-375	A, XA or B-61014	.95	.85	.65	.55	.45	.40	.35	.28
RSL-500	A, XA or B-81420	.95	.85	.65	.55	.45	.40	.35	.28
RSL-750	A, XA or B-122026	.95	.85	.65	.55	.45	.40	.35	.28
RSL-1000	A, XA or B-162536	1.25	1.00	.75	.65	.53	.47	.40	.33
RSL-1250	A, XA or B-203242	1.95	1.60	1.20	1.10	.88	.78	.66	.54
RSL-1500	A, XA or B-243848	2.50	2.35	2.20	2.05	1.90	1.75	1.60	1.45

*\*Larger sizes not available at this printing. Consult factory for information on availability of new types for all sizes.*

Each Mount is an assembly set consisting of five pieces as shown:  
2—Retaining Rings (C-type)  
2—Spacer Rings  
1—Neoprene Ring

Prices and housing bore recommendations are shown here. Neoprene ring is a press fit which assures adequate retention in the housing bores specified. Durometer of Neoprene ring is 60.



**THOMSON  
INDUSTRIES, INC.**

MANHASSET  
NEW YORK

Plants: PORT WASHINGTON, LONG ISLAND, N. Y. • LANCASTER, PENNSYLVANIA

**TERMS AND CONDITIONS OF SALE** — All prices are F.O.B. factory. Terms are 30 days net. No returns or cancellations accepted without consent. Defective material will be replaced without charge if promptly returned but no liability is assumed beyond such replacement. No responsibility is

assumed for damages arising from delivery delays, fires, strikes, material shortages, accidents or any other cause whatsoever and purchase orders are accepted subject only to these conditions irrespective of statements or stipulations on purchase order. Prices subject to change without notice.

## 60 Case Hardened & Ground Ball Bushing SHAFTS

The shaft on which the BALL BUSHING operates acts as the inner bearing race. To assure a long service life for all but lightly loaded applications, it should be hardened to Rockwell 58-63C to an adequate depth. To provide smooth operation and high precision, it must be smooth, round and unusually straight. 60 Case hardened and ground shafts are of highest quality to meet these requirements . . . are manufactured specifically for BALL BUSHING applications on equipment specially developed by THOMSON INDUSTRIES, INC.

**60 Case SHAFT SPECIFICATIONS** — 60 Case parts (of 1060 Steel) are case hardened to Rockwell 58-63C. Stainless Steel 60 Case is hardened to Rockwell 50-55C. Ends are chamfered 1/16" x 45° but not precision finished unless otherwise specified. 60 Case shafts are unusually straight and within .001/.002" per foot depending on size. Straighter shafts can be supplied at slight extra cost. Surface finish is from 16 to 24 micro inches rms. The length tolerance is  $\pm 1/32$ " for shafts up to 2"-diameter and  $\pm 1/16$ " for shafts 2" and over. Closer length tolerance can be maintained at extra cost.

**SPECIAL MACHINING** — Complete facilities are available for special machine work. When special machine work is required, send a sketch or print with your request for quotation and advise the quantity required.

**STOCKED FOR IMMEDIATE DELIVERY** — 60 Case hardened and ground shafts are carried in a factory stock for immediate shipment from Lancaster, Pa., cut to the required length, with or without special machining.

**RANDOM LENGTHS** — 60 Case is available in random lengths. These lengths exceed slightly the listed catalog lengths. The \$5 set-up charge is waived if your order indicates random length and pricing is based on the actual number of inches shipped.

**LONGER LENGTHS** — For information concerning lengths longer than listed below please contact factory.

FOR FURTHER INFORMATION — See Catalog Page 18.

**Table V — SOLID 60 Case Hardened & Ground SHAFTS — Material: 1060 Steel**

(ALSO AVAILABLE IN OTHER DIAMETERS FOR OTHER USES)

The following tables show diameters and prices of shafts normally recommended for use with the various grades of BALL BUSHINGS.



Nominal Dia.	Please specify Tolerance "Class" on order						Minimum Depth of Hardness	Price Per Inch of Length
	Class "L" Shaft Dia. For use with Series XA, ADJ, OPN and Normal Fit Series B Ball Bushings	Max. L'gth. (feet)	Class "S" Shaft Dia. For use with Series A and Press Fit Series B Ball Bushings	Max. L'gth. (feet)	Class "D" Shaft Dia. For use with Series DS Ball Bushings	Max. L'gth. (feet)		
1/4"	.2495/.2490"	8'	.2490/.2485"	8'	—	—	.040"	\$0.10
3/8"	.3745/.3740"	12'	.3740/.3735"	12'	—	—	.040"	0.13
1/2"	.4995/.4990"	12'	.4990/.4985"	12'	—	—	.060"	0.15
3/4"	.7495/.7490"	16'	.7490/.7485"	12'	—	—	.060"	0.20
1"	.9995/.9990"	16'	.9990/.9985"	12'	—	—	.080"	0.30
1 1/4"	—	—	—	—	1.0000/1.0003"	12'	.080"	0.40
1 1/2"	1.2495/1.2490"	16'	1.2490/1.2485"	12'	—	—	.080"	0.40
1 3/4"	—	—	—	—	1.2500/1.2503"	12'	.080"	0.55
2"	1.4994/1.4989"	16'	1.4989/1.4984"	12'	—	—	.080"	0.50
2 1/2"	—	—	—	—	1.5000/1.5003"	12'	.080"	0.65
3"	1.9994/1.9987"	16'	1.9987/1.9980"	12'	—	—	.100"	1.25
3 1/2"	—	—	—	—	2.0000/2.0003"	6'	.100"	1.50
4"	2.4993/2.4985"	16'	2.4985/2.4977"	12'	—	—	.100"	1.50
	2.9992/2.9983"	16'	2.9983/2.9974"	12'	—	—	.100"	2.00
	3.9988/3.9976"	16'	3.9976/3.9964"	12'	—	—	.100"	3.00

**Table W — Solid STAINLESS STEEL 60 Case Hardened & Ground Shafts —**

Material: 440C; Hardness Rockwell 50-55 "C"



Nominal Dia.	Please specify Tolerance "Class" on order		Max. Length (Feet)	Minimum Depth of Hardness	Price* Per Inch of Length
	Class "L" Shaft Dia. For use with Series XA, ADJ, OPN and Normal Fit Series B Ball Bushings	Class "S" Shaft Dia. For use with Series A and Press Fit Series B Ball Bushings			
1/4"	.2495/.2490"	.2490/.2485"	5'	.040"	\$0.40
3/8"	.3745/.3740"	.3740/.3735"	12'	.040"	0.40
1/2"	.4995/.4990"	.4990/.4985"	12'	.060"	0.40
3/4"	.7495/.7490"	.7490/.7485"	12'	.060"	0.55
1"	.9995/.9990"	.9990/.9985"	12'	.080"	0.80
1 1/4"	1.2495/1.2490"	1.2490/1.2485"	12'	.080"	1.10
1 1/2"	1.4994/1.4989"	1.4989/1.4984"	12'	.080"	1.25
2"	1.9994/1.9987"	1.9987/1.9980"	12'	.100"	3.25
2 1/2"	2.4993/2.4985"	2.4985/2.4977"	12'	.100"	4.25

**Table X — TUBULAR 60 Case Hardened & Ground SHAFTS**



Nominal O.D.	Nominal I.D.	Please specify Tolerance "Class" on order		Max. Length (Feet)	Minimum Depth of Hardness	Price* Per Inch of Length
		Class "L" Shaft Dia. For use with Series XA, ADJ, OPN and Normal Fit Series B Ball Bushings	Class "S" Shaft Dia. For use with Series A and Press Fit Series B Ball Bushings			
1 1/2"	.890" $\pm 5\%$	1.4994/1.4989"	1.4989/1.4984"	12'	.080"	\$0.75
2"	1.250" $\pm 5\%$	1.9994/1.9987"	1.9987/1.9980"	12'	.100"	2.00

**NET PRICES** — The small quantity net prices of 60 Case shafts without special machining are computed from the "Price per Inch" schedule shown above. When using "Price per Inch," price to the nearest inch when the shaft length ends in a fraction. In cases of a 1/2" fraction, add half of price per inch. A \$5 charge per size is added to each order to cover cut-off, order handling and small quantity boxing. This \$5 set-up charge is omitted on orders of \$500 or more. All prices are f.o.b. Lancaster, Pa.

### 60 Case Large Quantity User DISCOUNTS

ORDER VALUE NOT INCLUDING SPECIAL MACHINING		
\$1000 to \$1999.99 Discount — 10%	\$2000 to \$2999.99 Discount — 20%	\$3000 & over Discount — 30%

